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Complete dentures: an introduction

J. F. McCord,¹ and A. A. Grant,²

This introductory article sets the scene for a series of articles on complete denture prosthodontics.

The purpose of this series is to reflect current changes in philosophy towards the prescription of complete dentures. To achieve these aims, this series will deal with trends in edentulousness and changes in perceptions to edentulousness to the treatment modalities in complete denture provision.

This series is not intended to replace standard textbooks of prosthodontics, but rather to serve as a chairside guide/*aide-mémoire* of clinical procedures for the general dental practitioner with an interest in complete denture therapy. The balance of emphasis in this series has been determined by the experience gained in dealing with difficulties acknowledged by practitioners and patient indictment of treatment they have received.

Over the past 30 years, surveys of adult dental health indicate that the prevalence of people, in developing countries, becoming edentulous is decreasing.¹ The figures for England and Wales covering 1968 to 1988 are presented in Table 1.

In the United Kingdom as a whole, the overall percentage of adults who were edentulous fell from 30% in 1978 to 21% in 1988.¹ A parallel study spanning 1985–1986 in the United States reported that 41% of adults over the age of 65 were edentulous.² According to Winkler in 1977,³ almost 50% of the 22.6 million edentulous Americans were 65 years of age or older. In parallel with this is the almost 50% drop in the number of complete upper and complete lower dentures (C/C) and relines provided under General Dental Service (GDS) regulations between 1970 and 1990 (Table 2). This table also indicates the relative percentages of the total cost to the (dental) budget.⁴

Although these statements are factually correct, they must be balanced, in the United Kingdom at least, by two separate factors. First of all,

a significant number of general dental practitioners have become independent practitioners, thus disengaging themselves from National Health Service regulations, therefore many dentures provided will be unrecorded.

A second, and professionally important, factor is the finding that many (edentulous) patients when examined on routine dental visits, require replacement dentures (normative need) although they themselves did not feel this need (perceived view). This indicates the potential for a possibly large reservoir of unmet need in the population, in general, and in the edentulous elderly population in particular.

Clearly, although the (edentulous) percentage of the adult population is estimated to continue to decrease into the next century, the provision of replacement complete dentures to those currently edentulous will present a considerable task to the dental profession in the United Kingdom.⁵

Two factors adding to the relative complexity of this task are:

- i) The reduction in teaching of prosthodontic technology and in decreased minimum requirements of completed cases during undergraduate curricula. This means that new graduates are potentially less able to provide a satisfactory prosthodontic service.
- ii) Those patients who are edentulous are becoming more clinically demanding either because of oral conditions present at the time of total tooth loss or the deterioration of anatomical, physiological and sometimes psychological well-being which often are sequelae of edentulousness.

For these reasons, a sound biological approach to complete denture construction is necessary and, although this will be emphasised

In this part, we will discuss:

- Changes in the levels of edentulousness
- Changes in the degree of complexity of treatment of edentulous patients
- Changes in how prosthodontics is reported in professional journals.

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Table 1

Percentages of adult edentulous patients in England and Wales, 1968–1988

Age	1968	1978	1988
65–74	79%	74%	56%
75 and over	88%	87%	80%
All ages	37%	29%	20%

in the next three parts, the dental practitioner must be aware of the scientific basis of complete denture construction. This is of very real relevance in the United Kingdom, where the dental practitioner, at present, is the sole licensed agent to undertake clinical prosthodontic treatment for a patient. Practitioners should be familiar with the technical aspects of complete denture construction in order that they may direct the fabrication of the prostheses for which they are clinically and legally responsible. Failure to communicate clearly with a dental technician cannot facilitate a harmonious prosthodontic team. The latter should be built out of mutual respect between clinician, nurse, technician and patient.

Recent laboratory-based studies have indicated that there would appear to be an increasing trend towards the dental profession not fulfilling their responsibility to technical colleagues who have received little or no training in relevant clinical sciences.⁶⁻⁸ Although two of these studies relate to removable partial dentures, they nevertheless reflect a trend for clinicians to abdicate their responsibilities in the prescription of a medical device.

While no apology should be made for an early reference to the biological basis of prosthodontics, due emphasis should be given to altering trends towards edentulousness among the population. Anecdotal and anamnestic comments among those already edentulous reflect perceptions that there was an inevitability of edentulousness.⁹ These perceptions were particularly prevalent among the working classes, especially in the north of Britain.

According to Todd and Lader,¹ there were interesting variations in perceptions towards edentulousness among dentate adults wearing partial dentures and among dentate adults who did not have a partial denture and these are listed in Table 3.

While dental health education must be credited with reduced levels of edentulousness among the population in general, the expansion of dental information in newspapers and magazines has made the general public aware of the very real benefits of dental implants. Unfortunately, many patients do not satisfy the clinical criteria for the provision of implant-retained/supported prostheses. Those patients who are deemed unsuitable for implants, for whatever reason, will doubtless develop a negative stereotype towards conventional complete dentures and these negative stereotypes may make a successful outcome of treatment doubtful.

Table 2

Details of the total numbers of complete dentures and relines provided under GDS regulations, 1970–1990

Year	No of C/C	No of relines	% of total cost C/C reline	
1970	831,000	130,060	13.52	0.56
1980	509,180	99,770	6.02	0.32
1990	369,370	80,740	3.57	0.21

Figures from Dental Practice Board

Table 3

Perceptions of dentate adults to edentulousness

Perception	Dentate and no RPD 1978 1988	Dentate and with RPD 1978 1988	
Very upsetting	53% 63%	34% 39%	
Slightly upsetting	24% 24%	29% 28%	
Not upsetting	23% 14%	27% 34%	

A final aspect of perceptions towards complete dentures lies among the profession. For the purposes of this series, a survey of articles on complete denture prosthodontics in three journals (*British Dental Journal*, *Journal of the American Dental Association* and *Journal of Prosthetic Dentistry*) indicated that, in comparison to 30 years ago, the percentage of prosthodontic articles had fallen from almost 30% to less than 10%.

Clearly this cannot be a facile comparison, as journals should reflect alterations in trends of treatment, and the developments during the past 20 years of adhesive techniques have significantly altered treatment trends. Concomitant with the reduction in (complete denture) prosthodontic publications is the risk that younger practitioners may be deprived of the opportunity to become acquainted with prosthodontic techniques beyond conventional undergraduate curricula.

Such a situation cannot be in the best interests of those requiring prosthodontic treatment and the purpose of this series is to serve as a convenient chairside guide for practitioners undertaking prosthodontic treatment. As this series is meant to supplement standard textbooks of prosthodontics, references will be used to enforce specific areas and to refer readers to key areas of general and prosthodontic literature.

1 Todd J, Lader D. *Adult Dental Health, United Kingdom*, 1988. London: OPCS, HMSO, 1991.

2 US Dept. of Health and Social Services. *Oral Health of United States Adults*. National Findings. NIH Publication No. 87. 2868. 1987.

3 Winkler S. Symposium on Complete Dentures. *Dent Clin N Am* 1977; 21: 197-198.

4 Dental Practice Board (Eastbourne): *Personal Communication*.

5 McCord J F, Grant A A, Quayle A A. Treatment options for the edentulous mandible. *Eur J Prosthodont Rest Dent* 1992; 1: 19-23.

6 Basker R M, Harrison A, Davenport J D, Marshall J L. Partial designs in general dental practice — 10 years on. *Br Dent J* 1988; 165: 245-249.

7 Walter J D. A study of partial denture design produced by an alumni group of dentists in health service practice. *Eur J Prosthodont Rest Dent* 1995; 3: 135-139.

8 Basker R M, Ogden A R, Ralph J P. Complete denture prescription — an audit of performance. *Br Dent J* 1993; 174: 278-284.

9 Fish E W. The Englishman's teeth. *Br Dent J* 1942; 72: 129-138.

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Clinical assessment

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In this article, helpful guidelines are given to the assessment of patients and their dentures. A simple assessment sheet is suggested to serve as a record of the initial assessment visit.

In this part, we will discuss:

- General assessment of the patient
- Assessment of (oral and facial) soft tissues
- Assessment of (oral) hard tissues
- Assessment of current dentures
- Possible treatment options.

The clinician is responsible for the diagnosis and treatment of a variety of basic parameters in respect of the provision of a complete denture service. These include the recognition of a broad spectrum of the relevant and applied anatomical, physiological and psychological conditions of each patient, with an understanding of the significance of each patient's medical status. The development of a treatment plan that leads to the prescription of appropriate prostheses follows and, finally, the clinician must ensure that the technical requirements for each prosthesis are clearly communicated to the technician. Existing complete dentures which, ideally, have been considered to be satisfactory by the patient, should also be carefully assessed as an essential aid to diagnosis and treatment planning.

This chapter will deal with the assessment of the edentulous patient and of his or her denture as a means of determining why the patient is seeking treatment and what special problems might be considered. Two distinct but nevertheless related assessments will be described, namely that of the patient and also of the patient's dentures.

Patient assessment

The importance of establishing a rapport with the patient cannot be overemphasised. The projection of an image as a caring and thoughtful clinician is the first step to achieving good rapport. There are a number of simple methods of developing good dentist–patient relations at the outset of treatment.

The first of these is practised by many experienced clinicians who take the opportunity to escort their patients from the waiting area to the surgery. In addition to the value of the exercise gained, this philosophy affords the clinician the opportunity to assess the mien, gait and physical appearance of each patient. Figure 1 indicates a 60-year-old edentulous woman wearing complete upper and lower dentures that have been worn for more than 20 years. In addition to obvious oro-facial ageing changes, there are tell-tale signs of 'support' problems on the bridge of the nose caused by spectacles. This, plus generalised loss of muscle bulk in the muscles of mastication, suggests that the patient's biological age equals, or possibly exceeds, her chronological age. Early warning signs of support and vertical dimension problems concerning complete dentures are thus clear (see Part 10).

The next, and arguably the most important, stage in both developing a rapport and effective assessment of the patient is to elicit the appropriate complaints/symptoms (ie pain, looseness, eating, speech problems, appearance etc.) and particularly the patient's expectations. Care should be taken to ensure that the patient's views are listened to and not misinterpreted by the clinician, as this may lead to subsequent problems. The importance of paying attention to what the patient says is critical and the clinician must establish that they are in no doubt what the patient means. Anecdotally, many experienced clinicians report that patients confide to them that 'you are the first dentist who has really listened to me'. It must be stated that it is during this phase of treatment that essential background information is gleaned.

The patient's psychological needs may be met by effective communication, including the influence of body image on acceptance of treatment. Similarly, the dentist must guard against the development of frustrations which may arise from communicating with an apparently 'difficult' and demanding patient.

The medical background of the patient is also easier to obtain from a patient who has had an opportunity to relax during a preliminary conversation designed to reduce patient apprehension. Dental patients may harbour fears over problems encompassing appearance, speech or serious illness and expression of these fears often requires careful questioning. Many conditions do not present overt signs but may cause extreme discomfort to the denture patient. For example, a replacement denture provided before the detection of low-grade deficiency states may call into question the value of the clinical service provided.¹ Practitioners may find it useful to use a simple questionnaire to assess the medical background, and a variety of such questionnaires are available.

For simplicity, the assessment of the patient will be sub-divided into soft tissue and hard tissue assessment.

Soft tissue assessment

The tone of the lips and cheeks may be assessed by asking fundamental questions (eg address, family details etc.) which tend to promote unguarded replies and provide an opportunity for useful observations. This form of questioning will also tend to indicate the functional rela-

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Fig. 1 Lateral view of 60-year-old edentulous patient with lack of lip support and 'support' problems on the bridge of her nose from spectacle-wearing

tionship of the lips and tongue to the dentures in speech (Fig. 2). For example, it is generally accepted that the tips of the maxillary incisor teeth touch the vermillion border of the lower lip during fricative ('f' and 'v') sounds. This can be assessed easily as can the assessment of sibilant sounds which reflect the closest speaking space as well as the appropriate positioning of the upper incisor teeth. In addition, the presence of facial asymmetry, atrophy or hypertrophy should be noted.

The oral mucosa should be checked routinely for the presence of ulcers, stomatitis, or frank pathology. The clinician should also note the presence of adverse soft tissue attachments to the edentulous ridges or any other abnormalities.

The presence of displaceable tissue, eg fibrous tuberosities, hyperplasia and fibrous ridges, should be noted and this may merit consideration/remedial action prior to complete denture construction. Similarly, the presence of minimally-displacive tissues should be recorded as these may require appropriate relief to be incorporated into the denture. A simple clinical test is to palpate the ridges firmly with a gloved finger; signs of pain or discomfort will indicate that the mucosa overlying the ridge is unable to tolerate much pressure (Fig. 3).

Hard tissue assessment

The edentulous ridges should be assessed for form, presence of retained roots, tori and degree of inter-ridge space. The classification of

ridge form by Atwood,² which has been modified by Cawood and Howell³ is a useful means of describing ridge shape, although it does not necessarily describe ridge consistency. It does, however, provide a useful *aide-mémoire* for inclusion in the patient's notes. The nature of ridges eg the presence of undercuts, knife-edge ridges should also be recorded, as they require subtle modifications to the master casts (ie relief) prior to processing.

In addition to the above, the clinician should assess the quality and quantity of the patient's saliva. This may affect decisions regarding selection of the impression technique and, further, relate to denture-retention potential. Diminished salivary levels may also sound a warning regarding possible frictional effects on the peri-denture tissues and may also contribute to altered taste perception.

When these factors have been assessed, the presence of anatomical, physiological or pathological factors may indicate that pre-definitive/transitional treatment is required (see Part 3).

A thorough assessment of the biological environment into which a prosthesis is planned is a *sine qua non* if the expectations and perceptions of the patient are to be realistically gauged. The clinician has to determine if the patient's expectations are realistic and, further to establish whether he/she feels confident that a successful outcome is achievable. If the patient's expectations are unrealistic and if the clinician has doubts that a successful outcome is outside their potential, then there are realistically only two options to consider:

- No treatment is commenced and/or
- Refer the patient to a clinician who specialises in prosthodontics.

This can only be answered fully if, following the above, an examination of the patient's dentures is made.

Denture assessment

While there is universal acceptance of a periodontal index of treatment needs⁴ and an index of need for orthodontic treatment,⁵ prosthodontists have been singularly unsuccessful in establishing an index of denture quality.^{6,7}

For that reason, a simple yet easy-to-follow scheme for the assessment of dentures is described. Practitioners are recommended to use a denture assessment template similar to that in Table 1 to ensure that an accurate record of findings is kept.

In essence, the denture assessment and denture-wearing history is structured as follows. (These procedures may seem tedious to the inexperienced clinician, but it is remarkable how simple it is to incorporate into a replacement denture features that may be the essential cause for patients seeking replacement dentures.)



Fig. 2 Stability of lower dentures plus phonetic aspects of function depend on there being appropriate functional relationship of the dentures to the lips, cheeks and tongue



Fig. 3 Mild blanching of atrophic mucosa is evident over the mandibular ridge. Palpation with a gloved finger will indicate the ability of the soft tissue over the ridge to withstand firm, digital pressure

General factors:

Denture-wearing history

Record the age of the present dentures, the frequency with which previous dentures have been replaced and the patient's experiences with these dentures. Note the denture base materials used and the condition of the dentures, including signs and sites of obvious wear and usage. It is also a useful idea to record the dietary habits of the patient to determine the range and consistency of foods eaten by the patient. At this stage, there is much merit in providing the patient with a biscuit and observing if and how it is eaten, the time taken to eat the biscuit and any signs of denture instability (see Part 5).

The above, in addition to helping diagnose if the patient functions with the denture, must be measured with how the patient perceives the denture. If function is perceived by the patient to be acceptable, and looseness and occlusal wear are the only complaints, then the clinician should consider the provision of dentures using a copy or replica technique.

Specific factors:

Extension of the complete upper denture

- Check the peripheral extension, including presence, fit and placement of the post dam. This may be done using a ball-ended bursisher to help determine the displaceability of tissues (Fig. 4).
- Appropriate utilisation of the functional width and depth of the sulcus should be present as these relate to function (Fig. 5).

Extension of the complete lower denture

- Check the extension of the denture base in relation to the optimal available denture-bearing area, ie half-way up the retromolar pads and functional extension onto buccal shelves and lingual sulci.
- NB Appropriate extension relates to stability; instability tends to result in patients being aware of (denture) movement in function.

Assessment of retention

- Retention of the maxillary denture may be assessed by placing the thumb on the palatal aspect of the maxillary canine and the forefinger on the labial aspect and via a rotation of the wrist, pulling the thumb labially. This is an assessment of the adequacy of the peripheral seal.
- A number of factors relate to retention⁸, namely peripheral seal, tissue fit and secondary factors such as support (displaceable tissue) and stability (muscle/occlusal imbalance). Neuromuscular control, particularly in the case of dentures worn regularly over many years, is an important secondary factor.
- Testing the retentive quality of the lower den-

Table 1	Complete denture assessment	
Denture details: time worn	Maxillary	Mandible
<i>Patient's perceptions:</i> Acceptable (A), not acceptable (N)		
<i>Dentist's perceptions:</i> Condition of dentures: A/N		
<i>Retention:</i> Tissue adaptation: A/N		
<i>Peripheral seal:</i> A/N		
<i>Border/peripheral extension:</i> Labial to ridge: A/N Buccal to ridge: A/N Lingual to ridge: A/N Posterior extension: A/N		
<i>C/C relationships:</i> RCP: A/N OVD: A/N Articulation: A/N		
<i>Teeth:</i> Plastic? Porcelain?		
<i>Appearance:</i> Lip support Incisal level Incisal plane Posterior planes Appearance		
<i>Ridges - Atwood order:</i> I, II, III, IV, V, VI		
<i>Denture bearing tissues:</i> Healthy Acutely inflamed Chronically inflamed Hyperplastic Flabby Hard tissue undercut Other		

tures is problematic as it tends to be intimately associated with stability (muscle control).

- A rough guide to retentive qualities of a complete lower denture may be gauged by assessing the resistance to vertical displacement. This may be evaluated by asking the patient to relax with his/her tongue at rest. Place a probe between the lower incisor teeth and assess the resistance to upward pressure of the probe and denture. Although a component of stability should be present, the presence of a peripheral seal should resist upward movement of the denture (Fig. 6).

Assessment of stability

- Stability of a denture may, generally speaking, be assessed via alternate pressing on the right and left occlusal surfaces of the premolar teeth to detect the presence of rocking or rotational movements. This may suggest the presence of fitting inaccuracies, underutili-

Fig. 4 The tissues involved in the post-dam area are not uniformly displaceable. Prior to defining the form of the post-dam on the master cast, the clinician should determine, using a ball-ended burnisher, the relative displaceability from the midline through the pterygo-hamular notch bilaterally

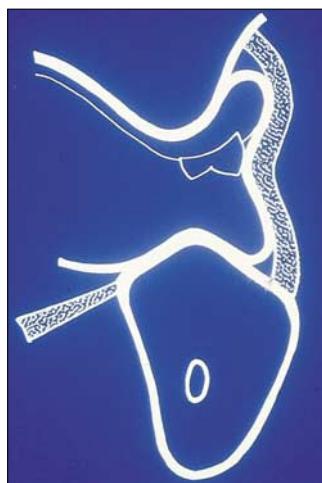


Fig. 5 As the attachment of buccinator remains essentially in the pre-extraction position and as the maxilla resorbs in a palatal direction, the clinician should use the functional width and depth of the sulcus to create a more ideal peripheral seal

sation of denture-bearing areas or support problems (ie flabby ridges) — this applies to both dentures.

- Assessment of the upper denture is generally performed with the operator standing behind the patient.
- The presence of inappropriate and adverse occlusal planes may result in stability problems as may some occlusal errors. For example, if the upper posterior planes dip posteriorly (Fig. 7) then the effect on closure of the dentures will be for the lower denture to slide anteriorly, often resulting in an ulcer lingual to the lower ridge.

Assessment of dentures as functional units

Upper tooth position

- This is usually directly related to the registration visit. A variety of subtly interconnected factors require to be established when dentures are assessed.
- Contribution to lip support: has the denture provided appropriate lip support? Upper anterior teeth placed on the ridge may affect speech, resulting in problems of instability with the lower denture and do not restore the vermillion border of the upper lip.
- Position of the mid-incisal point. This is a function of appropriate lip support and if the correct position is not achieved or if the maxillary denture teeth are set on the ridge,

the mid-incisal point may be placed inappropriately (Fig. 8). The exception is a patient who has been recently rendered edentulous or has a large, undercut anterior ridge; in these cases, a full labial flange may not be appropriate.

- Angulation of the incisal plane. A useful guideline is that this should be parallel to the interpupillary line.
- Angulation of the posterior occlusal planes. Conventional wisdom suggests that these be made parallel to the ipsilateral alar-tragus lines. Reference has already been made to inappropriate occlusal planes and their effect on lower dentures.

Lower tooth position

- It is generally accepted that, in the interests of (lower) denture stability, the central fossae of the lower posterior teeth and the necks of the lower anterior teeth should lie over the residual mandibular crest.
- Relation of lingual cusps to resting tongue height. By convention, the tongue, at rest, should lie at the level of the lingual cusps of the lower denture.
- The presence of lingual undercuts should be avoided as these may lead to denture instability (Fig. 9). This factor may be extended in the case of patients with an atrophic mandible. In these cases, it is considered prudent to position the mandibular teeth in a position of minimal muscular conflict (neutral zone — see Part 4).⁸
- The presence of molar teeth over the ascending portion of the mandibular ramus tends to encourage displacing movements of the lower denture and this practice should be avoided (Fig. 9).

Occlusal relations in retruded contact position (RCP)

The minimal requirements for any complete dentures should be that they exhibit balanced occlusion in retruded contact position.^{9,10} In



Fig. 6 The patient in this photograph has developed excellent denture control via a muscular balance of tongue, cheeks and lips

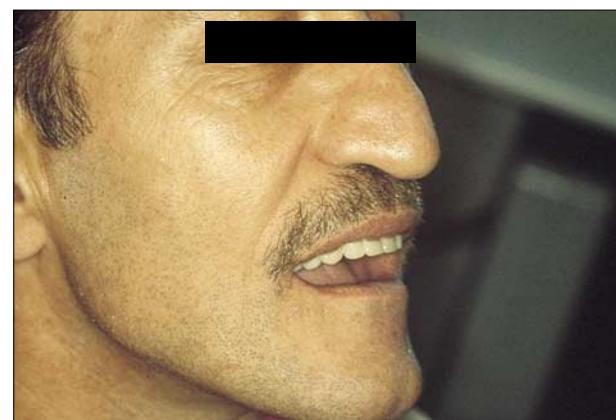


Fig. 7 The inappropriate form of the posterior occlusal planes of this upper denture will, in addition to producing a poor aesthetic result, result in unstable lower dentures

essence, this means that there should be simultaneous and even bilateral contacts in RCP. This should be established with the operator's forefinger placed on the buccal periphery of lower dentures to assist stability. The operator should detect any slide, be it protrusive or lateral, as these will tend to de-stabilise the lower denture. N.B. For protrusive and lateral movements to take place, appropriate anterior and buccal overjets must be present and the presence of incisal and/or cuspal locking detected and eliminated where required.

Assessment of appropriate freeway space

This is measured indirectly by subtracting the occlusal vertical dimension from the resting facial height (RFH-OVD). Clinicians should determine the biological capacity of the patient to withstand occlusal loading and prescribe the OVD appropriately.

Is balanced occlusion or balanced articulation required?

As has been mentioned earlier, the clinician is advised to determine the masticatory needs of the patient at an early stage in the diagnosis/treatment planning stage. Examination of the occlusal surfaces of the dentures may assist in the determination of whether balanced occlusion or balanced articulation is prescribed. Alternatively, the biscuit test or other such functional test may be used. If balanced articulation is selected, then continuous and dynamic occlusal contacts should be present in border movements of the mandible, in addition to RCP — this is demanding of the skills of the prosthodontist and of the technician! The importance of assessing this occlusal requirement should not be overlooked at this stage. Technicians as a rule do not see patients and thus are not able to advise on the occlusal scheme appropriate for the patient. We advocate that this assessment be made at the time of the initial visit as it is part of the diagnostic process — most registration techniques only record RCP and do not consider occlusal requirements of a patient.

Does the patient experience pain when dentures occlude?

If this is the case, the clinician must determine whether the cause is systemically-related, occlusally-related or related to a support problem (see Part 10).

Do speech problems occur when dentures are worn?

Although this will also be dealt with in Part 10, the clinician should ensure that these speech problems are not present when no dentures are worn or with other, unassociated dentures.

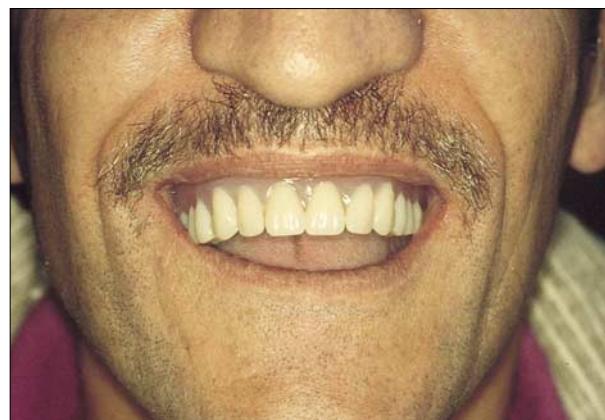


Fig. 8 In addition to not being in the mid-line of the face, the mid-incisal point is poorly sited antero-posteriorly and vertically with subsequent functional problems



Fig. 9 The lower molars pose two problems:
1. Their excessive bucco-lingual width presents lingual undercuts to the tongue, thereby inducing denture instability.
2. The second molars are sited on the ascending portion of the mandible, encouraging an incline-plane effect on the lower denture

Does retching occur and if so, when?

This not uncommon and functional condition is best recognised and treated prior to definitive treatment and usually involves a period of desensitising and/or provision of a training plate.^{11,12}

Assessment of appearance

Although strictly speaking not a functional component, this important aspect of denture assessment does relate to the functions of mastication and speech. Important factors to assess here are:

1. Appearance of anterior teeth — is there appropriate:

- Upper lip support*
- Restoration of philtrum*
- Tooth shade, mould and arrangement*
- Buccal corridors*
- Harmony of gingival matrices of anterior and posterior teeth*
- Lower lip support*

*see Part 5

2. Posterior aesthetics — are these appropriate:

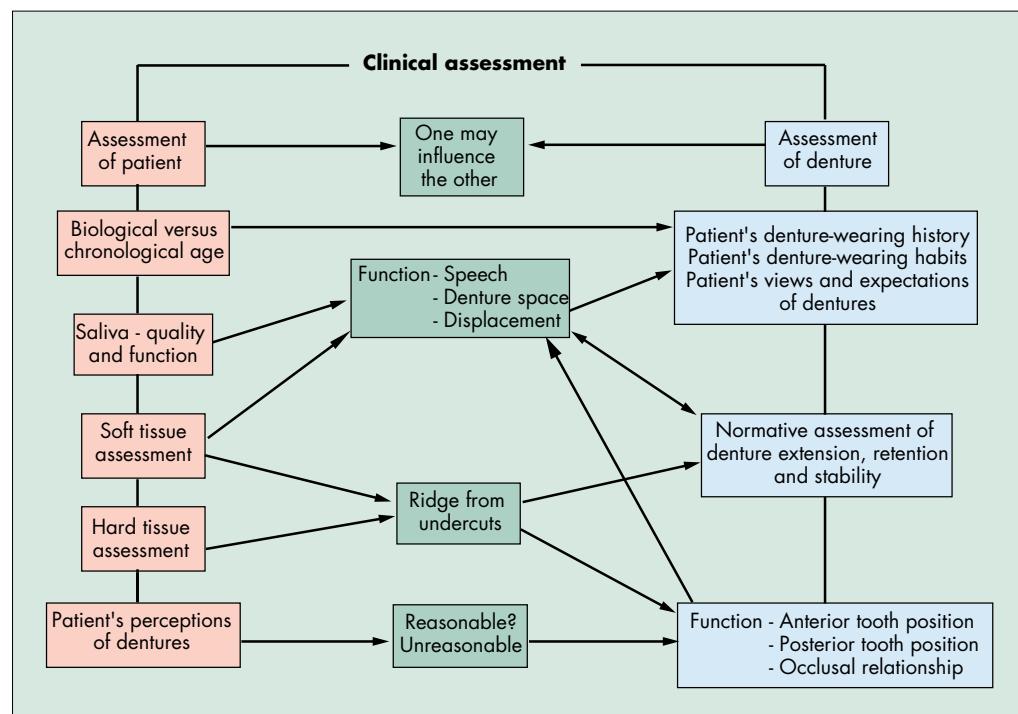
- Occlusal planes
- Anatomical and natural flow from anteriors to posteriors
- Gingival contours.

Other aspects of denture assessment

Remove both dentures and assess the following:

Fig. 10 Algorithm of clinical assessment for replacement complete dentures

- 1 Grant A A, Heath J R, McCord J F. *Complete prosthodontics: problems diagnosis and management*. P25, London: Wolfe, 1994.
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- 11 Barsby M J. The use of hypnosis in the management of 'gagging' and intolerance to dentures. *Br Dent J* 1994; 176: 97-102.
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- Impression surface of each denture. Ensure no surface irregularities are present — these may well induce support problems.
- Polished surfaces of each denture. These should be free of undercuts and should conform to the structures surrounding the denture space.
- Occlusal and incisal surfaces of each denture. Ensure that the relationship of teeth to the indentation of the ridge on the impression surface is as described above. In the case of the upper anteriors, a device such as the Alma gauge may help relate these teeth to the incisal papilla (see Part 5). In the case of the lower posterior teeth, a wax knife may be used to relate the lower posteriors to the ridge (see Part 8).

When the assessment of the patient and the patient's dentures have been made, a realistic diagnosis of any real or potential problems, may be made. Figure 10 is an algorithm of how patient and denture assessments may relate.

Reference has been made previously to the importance of taking into account the views of the patient. If the patient does not co-operate, then a successful outcome cannot be predicted.

As with all other branches of medicine/

Helpful Hints

- 1 Assess the denture environment.
- 2 Assess the patient's expectations.
- 3 If 1 is perceived to be generally satisfactory and 2 is supportive, consider a replica denture technique.
- 4 If 1 is perceived to be less than desirable by dentist and patient and 2 is supportive of dentures in general, a replacement denture should be considered.
- 5 If 1 is (normatively) perceived to be acceptable and 2 is unfavourable then either the assessment of the denture is not thorough enough or the patient's expectations are perhaps unattainable. It would be sensible to enlist the opinion of a specialist — or do not treat!

dentistry, the maxim 'no diagnosis, no treatment' is worth bearing in mind. Only when an accurate diagnosis is made may a realistic treatment plan be formed.

Decision-making factors will be discussed in Part 3.

Correction

Because of a font problem on page 263 of issue 5 of the *BDJ* on 11 March 2000 in the article by P. Hollows *et al.* on "Delays in the referral and treatment of oral squamous cell carcinoma", some of the symbols were incorrectly indicated: all c^2 's on this page should read χ^2 . We apologise for any inconvenience caused

3

Pre-definitive treatment: rehabilitation prostheses

J. F. McCord,¹ and A. A. Grant,²

This article deals with the treatment of common conditions affecting the denture supporting tissues. Several preliminary (non-definitive) treatment options are presented along with a brief account of their rationale.

In this part, we will discuss:

- Common soft tissue conditions
- Common hard tissue conditions
- Rehabilitation devices.

In formulating a treatment plan for the edentulous patient, early decisions must be made regarding essential oral tissue rehabilitation and other necessary pre-prosthetic measures. It is essential that the mouth is in an optimal state of health prior to commencing prosthetic treatment, and failure to achieve this may well produce an unsatisfactory treatment result. The latter is therapeutically unacceptable as well as being ethically questionable.

While some patients may present for their first denture with underlying conditions, it is more common to find that those seeking replacement appliances are in need of pre-prosthetic treatment. This may be because of the long-term consequences of denture wearing, and may also relate to the greater likelihood of systemic conditions having oral consequences in the age group concerned.

In essence, problems that may benefit from preliminary treatment might involve both soft and/or hard tissues.

It should be appreciated that the following lists are not exhaustive as only the more commonly encountered conditions will be dealt with. Rare and more complex problems should be the subject of referral for treatment by a specialist. The lists are included for the sake of simplicity, as many conditions cannot be compartmentalised and may occur simultaneously, and be complicated by oral manifestations of a general disease state.

Some treatment measures may require what might be termed 'rehabilitation devices'. These are considered separately later in this chapter together with comments on their usefulness. Depending on a variety of situations, the den-

tist may find it necessary to modify the patient's existing dentures or, occasionally, to construct a special appliance, as the old denture may be irreversibly altered.

Common soft tissue conditions are:

- Tissue distortion
- Denture-related stomatitis
- Angular cheilitis
- Fibrous degeneration of the residual ridge(s)
- Border faults
- Hyperplasia of the border tissues.

Common hard tissue conditions are:

- Unerupted teeth and retained roots
- Sharp bony ridges
- Enlarged tuberosities
- Tori and other bony prominences
- Sharp mylohyoid ridges.

Common soft tissue conditions

Tissue distortion

A soft tissue-supported denture may become ill fitting because of continuing resorption or tooth wear. Both may result in uneven forces being directed to the underlying mucosa and these tend to cause distortion of the surface contours of the residual ridges. This results from the unbound tissue fluid being driven from its normal resting position.

An impression of the tissues in their distorted state, when poured in gypsum, will reproduce the distorted form of the residual ridges (Fig. 1). A denture made using such a cast will only fit the patient as well as the denture it replaces.

Distortion is most evident where thickened mucoperiosteum is present and while some signs of inflammation may be seen, there may be little or no obvious signs of deformation.

Fig. 1 The displacement of this fibrous tuberosity is obvious. Displacement or distortion of thinner, more displaceable fibrous mandibular ridges will pose support problems for lower dentures



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The tissues will recover their stable form if the cause of the distorting force is removed and this recovery in such cases, in theory, is a time-dependent phenomenon. At least 90 minutes after removal of the old denture should be allowed prior to obtaining working impressions. Where distortion is obvious and severe, tissue recovery will take much longer and it may be necessary for the old dentures to be removed for several hours.

Fig. 2 This slide illustrates a case where the maxillary anterior ridge is obviously readily displaceable; inappropriate impression techniques are likely to result in dentures of inappropriate surface form and tissue contact



There can be no denying that the optimal denture-related tissue option is to leave the dentures out for several hours before attending surgery. For most patients this is an unacceptable option and would lead to social embarrassment, an occurrence that should always be avoided. Moreover, it is also not a feasible option to keep a patient in a surgery chair while the tissues resolve. The clinician, however, may improve matters by relieving denture undercuts and carrying out a chairside reline using a thin resilient lining material such as Visco-gel™ (Dentsply Limited, Surrey) over a 24-hour period. Patients should be encouraged, however, to remove their dentures whenever it is socially convenient to do so (ie when they are in the house alone).

Denture-related stomatitis

Where chronic irritation of the mucosa contacted by a denture base has occurred, an inflammatory condition may be observed. It is most commonly associated with the upper denture and may be seen as a vivid inflammation of the whole area covered by the denture. In the early stages, discrete areas of pinpoint inflammation can be seen in the region of the palatal mucous glands. A further form is described as papillary hyperplasia in which a nodular hyperplasia of the central palatal area is seen.

The condition is usually symptomless and the patient may be unaware of its presence.

A large number of causative factors have been implicated, the most common of which is denture-related trauma. The trauma may arise from occlusal faults (static or dynamic), poor denture hygiene, poor fit of the denture base, or roughness of the denture base. These are all fac-

tors that may be present in dentures which have been used over a prolonged period. The condition may be associated with the presence of *Candida albicans*, invasion of which appears to be stimulated by trauma to the affected tissues, and particularly when the dentures are worn continuously.

Other factors implicated in denture-related stomatitis include endocrine disorders, deficiency states, opportunistic infection associated with antibiotic therapy and associated with xerostomia.

Denture-induced trauma is resolved most effectively when the patient is not wearing the dentures. If this is not practicable — as resolution may take up to 6 weeks to effect — alternative measures are required. Where the trauma arises from ill-fitting bases, stabilisation of the denture by means of tissue conditioners may be carried out. This may have to be repeated perhaps several times until the condition is resolved, as tissue conditioners in use over several weeks can themselves be a source of trauma.

Where occlusal or articulation faults are present, the dentures will require more radical modification to remove the effects of trauma and this is considered in the section on rehabilitation devices (see previous page).

Angular cheilitis

This painful and unsightly inflammation of the corners of the mouth results from constant wetting of the angles of the mouth by saliva. It may be caused by lack of lip support following tooth extraction, poorly designed denture flanges not providing adequate lip support or loss of occlusal vertical dimension.

Other causes include vitamin deficiency and iron deficiency. Secondary infection by staphylococcal organisms may occur, but it may be associated with an intraoral candidal infection. Where denture-related stomatitis and angular cheilitis occur together, *Candida albicans* is almost certainly implicated, in which case antifungal agents eg Miconazole will be required as part of the treatment. Bear in mind that the denture in such a case is a source of infection and it must be placed in a suitable antifungicide — such as dilute hypochlorite — overnight.

Fibrous degeneration of the residual ridge

One result of prolonged denture wearing may be the development of a hypermobile, readily displaceable ridge form. This can be disadvantageous to the production of a stable denture. Such a readily displaceable form is also subject to the greatest tissue distortion (Fig. 2). Thus a prolonged period of recovery is required before commencing the impression stage of treatment and special impression procedures are required (*vide infra*).

Surgical procedures may be considered where fibrous degeneration has occurred, but these should be approached with caution and considered as a last resort.

Border faults

Where a denture has been worn for a prolonged period of time the presence of border faults might be anticipated. The most common of these is over-extension, but where the borders were inaccurate at insertion, then there may be regions of overextension and others of under-extension.

Where over-extension is present, the resultant trauma will produce tenderness, swelling and possibly ulceration (Fig. 3).

Overextended regions must be relieved and the patient instructed to return for further examination in 1 week. If, at that stage, recovery is not complete, the procedure is repeated until complete healing has taken place. Treatment may then proceed to the impression stage.

Occasionally, a frenum or muscle attachment is so prominent that it prevents the creation of an adequate peripheral seal. In such cases, it may be necessary to consider surgical repositioning of a muscle attachment, or removal of frenal tissue. The surgical treatment must be supplemented with the production of a stent, or modified prosthesis, during the healing phase in order that the operated condition might be maintained. Stents will be considered further in the section on rehabilitation devices below.

Hyperplasia of the border tissues

A result of chronic irritation produced by an overextended border may be hyperplasia of the tissue. This can be painless and the patient is often unaware of its presence. Sometimes, however, where the mass of hyperplastic tissue is large, patients may show concern — often about the possibility that such a 'growth' is malignant.

The source of irritation must be removed. This requires reduction of the over-extended flanges, or possibly removal of the entire denture flange. Where the areas concerned are extensive, the preferred treatment is for the denture not to be worn. The patient should be encouraged to massage the hyperplastic tissue with the ball of the finger. Reduction of the denture flange and resolution of the tissue mass will have the effect of the denture feeling loose, and the patient should be warned of this.

Over a period of some 4–6 weeks much, if not all, of the tissue mass will resolve. Surgery may be indicated if resolution is incomplete, but this should be only after the conservative approach described above has been completed, and as a last resort.

Common hard tissue conditions

Unerupted teeth and retained roots

Where there is some irregularity of the shape of the bone or because of painful symptoms in an apparently normal region, a radiograph should be taken of the area. This may disclose a root or unerupted tooth or even a dental cyst.

A root or unerupted tooth that is deep, completely invested in bone and shows no evidence of pathological change need not necessarily be removed as undue loss of alveolar bone would result. Preservation of residual bone and favourable ridge contour is of far greater importance than removal of an entity simply because it has been discovered. The patient should, of course, be informed of the findings and the decision.



Fig. 3 The classic signs of erythema, swelling and ulceration are clear where over-extension has occurred in the (left) post dam area

Where a tooth or root is only partly in bone and is in contact with overlying soft tissue, then removal is advised, taking into account such factors as the age and medical status of the patient, etc.

Sharp bony ridges

This condition may occur on the crest of the lower ridge in the anterior region (Fig. 4) or may manifest as sharp mylohyoid ridges. It can be painful for the patient owing to forces generated during chewing displacing this, or even fibrous mucosa, onto the bony spicules. Surgical smoothing of such a ridge may produce temporary relief, but it must be appreciated that continuing resorption may cause the condition to recur. A conservative approach to overcom-



Fig. 4 Occlusal view of mandibular ridge. The anterior aspect of the ridge is clearly a knife-edge profile

ing the problem is recommended, at least in the first instance. This will include relief of the master cast (eg 1 mm tin foil over the relevant area of the ridge crest of the cast) and reduction of the load applied to the tissue by decreasing the size of the occlusal table or, in appropriate cases, increasing the freeway space. Where the overlying mucosa is displaceable, a special impression technique (Fig 12a-c, Part 4) should be used.

Enlarged tuberosities

Enlarged tuberosities may be bony or fibrous in nature, and it is important to discriminate between these by means of radiographs if it is necessary to provide treatment. The size of the tuberosities may be such that it is impossible to insert a fully extended denture flange either because of the size of undercut (the denture flange prevents movement of the coronoid process) or the tuberosity contacts the opposing retromolar pad (Fig. 5). In the experience of the authors, enlarged tuberosities are rarely subjected to the surgeon's knife or drill.



Fig. 5 Bulbous tuberosities present problems of planning for retention and for inter-ridge space

As a good rule of thumb, however, if the inter arch space cannot accommodate 2 mm of denture base (1 mm for the upper denture and one for the lower denture) then surgery will be required.

Where the tuberosity enlargement is bony in nature and contains an extension of the maxillary sinus, surgical reduction is not an easy option. In this case the undercuts must be blocked out during denture fabrication and/or a specific path of insertion of the denture must be selected.

Where there is adequate bone present and where mobile large fibrous tuberosities impinge into the lower ridge, surgery to produce a firm, stable base might be undertaken.

Tori and other bony prominences

Bony prominences may be present in the form of maxillary or mandibular tori, prominent maxillary midline suture or anterior nasal spine or as an exostosis in some less common site. The common problem resulting from these structures relates to the generally thin mucosal covering, relative to the overall

denture supporting tissues. This can cause discomfort and/or instability of a denture unless adequate and accurate relief is provided in the denture. The relief area must be no deeper or extensive than the case in hand requires, or loss of retention of the denture may result. If the extent of the bony prominence is ill-defined, the assistance of a disclosing paste will be required to outline the area to be relieved.

Occasionally, an exostosis or torus may be so large and/or undercut as to prevent denture insertion, or cause the baseplate to excessively encroach on the available space in the oral cavity. Particular examples are:

- **Maxillary torus:** If this extends onto the post dam area and peripheral seal is significantly reduced, surgery will be required.
- **Mandibular tori:** If these are large enough to significantly reduce the width of the tongue space anteriorly, surgery will be required.

In these circumstances, surgical modification of the bony contour will need to be considered.

Rehabilitation devices (transitional prostheses)

This is a term that is used to describe those appliances which are used either as primary devices, to prepare a patient for prosthodontic treatment, or as an adjunct to surgical pre-prosthetic procedures.

The most commonly used of these include:

- Conditioning appliances to desensitise patients who suffer from gagging
- Pivots used to assess tolerance to vertical dimension increase
- Pivots used as a diagnostic appliance for patients having a history of intolerance to a lower denture
- Stents for use following surgery to the border tissues
- Transitional prostheses for patients with exceedingly worn prostheses.

Conditioning appliances

A conditioning appliance, or training plate, may be provided for home use for a patient who suffers from nausea or gagging when wearing a denture.¹ The most common causes of gagging are looseness/rocking of the denture, excessive thickness of the posterior border of the upper denture (particularly when it is placed forward of the vibrating line), or a narrow arch form that forces the lingual cusps of the upper posterior teeth to impinge on the dorsum of the tongue. There can also be a strong behavioural/psychological aspect to this problem, and as an approach to developing the necessary confidence in the sufferer to feel motivated to overcome the problem, a training plate can be helpful. The training plate must be fully extended and properly tapered in thickness at

the posterior border that must be provided with a carefully formed post dam. A finger grip may be provided so that the patient can control insertion and removal of the device (Fig. 6).

Additionally, psychological assessment might be appropriate for some patients, in association with some adaptational/self-controlling measures such as auto-hypnosis and controlled breathing (*see Part 2*).^{11,12}

Occlusal pivot appliances

Where excessive freeway space is present with existing dentures, it is not advisable to increase the denture height beyond some 3 mm at a time unless the tolerance of the patient to a greater increase is first determined. This can be achieved by the use of occlusal pivots.²

Occlusal pivots consist of two flat-surfaced pillars of acrylic resin placed bilaterally in the second premolar and first molar region of the lower denture. These planes must contact the opposing teeth of the upper denture bilaterally and evenly. Pivots can also be used where a gross error in the retruded contact position (RCP) of occlusion is present, to increase the stability of the denture bases and thus reduce trauma to the underlying tissues.

Pivots are made using thin tin foil placed on a paste of self-polymerising polymer (methyl methacrylate) (PMMA) added to the occlusal surfaces of the second premolar/first molar region of the lower denture. The denture is seated in the mouth and the patient instructed to close gently into RCP. Closure must cease when bilateral contact is made to prevent displacement of the acrylic dough. The denture is then removed from the mouth and the PMMA cured, after which the occlusal contacts are confirmed as simultaneously bilateral and at the required occlusal vertical dimension.

The tin foil is then removed and the occlusal pivots are polished with the occlusal surfaces made flat.

Given the increased trend towards potential litigation, there is merit in considering adapting this technique by applying the pivots to a 'copy' denture, to ensure that the patient's original denture remains intact, in case the outcome of this treatment does not prove to be successful.

Other applications for pivots

If a patient has never successfully managed a complete lower denture, or is unable to provide a reproducible RCP, occlusal pivots may be helpfully prescribed initially in the replacement denture. In such cases, denture production proceeds conventionally up to the trial denture stage, after which the lower posterior teeth are removed and replaced by wax pivots. These are converted to PMMA pivots during processing (Fig. 7).

As with the pivots described earlier, care must



Fig. 6 Training plate which may be used in the treatment of a patient with a retching problem

be taken to ensure that occlusal contact on the flat planes is bilateral and even.

In review visits, occlusal adjustments can be made and pressure relief provided as necessary, until comfort and a reproducible RCP is achieved. When this occurs, an occlusal registration can then be obtained and the posterior teeth added.

Stents

Where border tissues have been subjected to surgery, such as for muscle attachment repositioning, frenal tissue excision, or a sulcus deepening procedure, a stent will be required to be used during the healing phase. The stent is made prior to surgery and is inserted immediately at the operation. If this sequence is not followed, there is likely to be a marked loss of sulcus depth rendering denture base extension and consequent compromise to retention and stability of the denture.

The stent must be of the form and required extent of a denture base. It is essential that the periphery of the device is highly polished, of rounded form having a minimum thickness of 2mm.



Fig. 7 Complete lower denture processed in the form of lower pivot prosthesis

'Stents' are also recommended, in the form of a surgical template, in dental implant surgery. When the wax try-in has confirmed the position of the teeth on the implant-supported prostheses, the try-in is duplicated in translucent PMMA and this surgical template is modified lingual to the anterior teeth to give an

Fig. 8 Example of translucent stent used prior to the placement of dental implants. Note the removal of base material, lingual to the suggested anterior tooth position, to facilitate placement of the bone drill and subsequent implants



indication to the placement of the implants (Fig. 8).

Although most general dental practitioners might not be normally expected to make such prostheses, they should be aware of the fact that they may be requested to make one by an oral surgeon, to whom they have referred a patient. These stents for either soft tissue management or implant placement, should be planned by the clinician providing the restorative care prior to surgery.

- 1 Basker R M, Davenport J C, Tomlin H R. *Prosthetic Treatment of the Edentulous Patient*. p184-185. London: Macmillan Press Limited.
- 2 Watt D M, MacGregor A R. *Designing complete dentures*. 2nd ed. p96-98. Bristol: Wright, 1982.

Helpful Hints

- 1 Attempt to restore soft tissues to appropriate level of health prior to commencing replacement dentures.
- 2 If hard tissue enlargement is such that inter-arch space will not permit placement of minimal denture bases, or if tongue space is constrained, pre-prosthetic surgery will usually be indicated.
- 3 Occlusal pivot appliance therapy is useful where patients have worn dentures over a lengthy period. Although the technique is simple, there is merit, for medico-legal reasons, in copying the existing denture and modifying the copy as a transitional denture — the existing denture is thus unaltered and can as such be returned to the patient if a successful outcome is not achieved.

4

Impression making

J. F. McCord,¹ and A. A. Grant,²

In this section, the clinical and technical aspects of conventional impression making are discussed and illustrated. In addition, examples of selective pressure impression techniques and functional techniques are presented.

In this part, we will discuss:

- Rationale and practice of primary impressions
- Planning of 'special' trays
- Rationale and practice of definitive techniques
- Further examples of good practice concerning teamwork

Following on from the diagnostic and preparatory phases of treatment, the impression visits provide the clinician with the opportunity to confirm the diagnosis of oral conditions and, of equal importance, to determine the likely degree of patient compliance to the treatment.

According to the *Oxford English Dictionary*, an impression is an imprint produced by 'the pressure of one thing upon or into the surface of another'. This implies an active role and not a passive role and the clinician should consider that impressions are made, not taken.

With this philosophical principle established, impression making for complete dentures may be categorised as follows:

Primary impressions

- Conventional techniques
- Template techniques

Definitive impressions

- Conventional techniques
- Selective pressure techniques
- Functional techniques
- Reline and rebase techniques (including secondary template impressions).

In this chapter, considerable emphasis is placed on impression techniques, as recent studies indicate that flawed impressions account for the majority of denture problems.¹ Two principal points to mention here are especially relevant. Lower impressions tend to be 'short' of the retromolar pads and do not accurately record the functional forms of the floor of the mouth and the retromylohyoid fossae. These deficiencies tend to result in an unstable denture. The

importance of recording the form of the floor of the mouth in relation to the mylohyoid muscle and the retromylohyoid fossae cannot be understated.

Primary impressions

Recent guidelines from the British Society for the Study of Prosthetic Dentistry (BSSPD) state that the requirements of the primary impressions are that they should accurately record clinical relevant landmarks of the edentulous mouth without excessive tissue distortion.² This implies that, by definition, the resultant impression is overextended. These guidelines also recommend the practice of using rigid stock trays, modified as necessary to 'fit the form of the denture-bearing area'. Table 1 lists the anatomical features that should be recorded.

A list of techniques will now be presented, to facilitate choice for the practitioner.

The basic function of primary impressions for complete dentures is to outline support. A secondary function is to provide the basis of a primary cast on which a customised or 'special' tray is made.

Trays for primary impressions

A large variety of trays is available for selection; some trays are metallic and have fixed handles, some are plastic with fixed or attachable handles. Although any tray could be used, consistently successful results tend to be produced when rigid trays of appropriate extension are used, especially when recording impressions of the mandibular arch (Fig. 1).

Trays for primary impressions tend to be selected from a supply of 'stock' trays which are designed to cover a broad range of arch forms

Table 1

Salient anatomical features of denture bearing areas

Maxillary arch

- i) Residual ridges, tuberosities and hamular notches.
- ii) Labial and buccal sulci. Muscle attachments and fraena.
- iii) Hard palate and the functional area between hard and soft palate.

Mandibular arch

- i) Residual ridges and retromolar pads.
- ii) Labial and buccal sulci, muscle attachments labial to ridge and fraena.
- iii) Lingual sulcus, lingual fraenum, mylohyoid ridge and retromylohyoid arch.

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and sizes. The clinician should examine the edentulous mouth and assess the length and width of the arch to be restored. When assessing the stock trays for size, the clinician is advised to place the distal portion of the tray just distal to the posterior landmarks of the tuberosities in the upper arch, and onto the retromolar pads of the lower. This enables the clinician to visualise the width of tray required to record the functional width of the sulcus ie the tray should extend 5 mm beyond the external surface of the residual ridge.

By keeping the posterior aspect of the tray in place and rotating the anterior portion of the tray towards the labial sulcus, the clinician can determine if the tray is of an appropriate length.

Care taken at this stage will ensure that over-large trays are avoided — this will reduce patient discomfort and reduce the likelihood of the incorporation of tissue folds at this stage. Under-sized trays will result in problems for the technician making the customised trays on undersized primary casts (Fig. 2). In consequence, the clinician will experience problems as undersized primary impressions commonly result in the production of inadequate definitive impressions and these may result in support and/or stability problems in the processed denture.

Selection of impression materials

A variety of materials may be used to record impressions for complete dentures (Table 2).

These materials differ in their ability to displace soft tissues and many clinicians hold fixed views regarding the clinical effectiveness of each material. These arguments are possibly less valid in the case of maxillary impressions, where an experienced clinician may obtain acceptable results with a well selected tray and many of these materials. Figure 3 illustrates an acceptable primary impression using an impression compound and a rigid stock tray — this result should be achievable by all practitioners.

Care is required, however, in the lower arch, as a poorly chosen tray and a conventional irreversible hydrocolloid impression material may not give the acceptable result obtained with more viscous materials.

Impression technique

Conventional technique

We would urge that clinicians reject the philosophy that 'it's only the first impression', as poor primary casts do not provide a good basis for customised trays, nor do they earn the clinician the respect of the technician.

When the stock tray of appropriate size has been selected, there is merit in practising insertion of the tray; ideally the clinician should be positioned to one side and behind the patient. In addition to confirming that the tray is suit-

able for size, it allows the clinician to educate the patient on how to control his breathing during the recording of the impression.

When the upper tray has been loaded with the impression material, and the upper lip everted, the tray is held inferior and anterior to the incisive papilla. The tray is inserted upwards and backwards to fill, first of all, the labial sulcus, then the left and right sulci before the palatal area is pressed into position. The clinician may have to change the operating hand to ensure the impression material records the right and left sulci.

With lower impressions, the clinician stands to one side in front of the patient, the tray is held over the lower ridge and the loaded tray depressed, the labial, right and left sulci in turn being everted to permit the impression material to fill the functional width of the sulci.



Fig. 1 An example of rigid, appropriately extended trays for primary impressions. The benefits of trays of this form, especially in the retromylohyoid area, have been endorsed by BSSPD guidelines



Fig. 2 This slide illustrates one of the problems faced by a technician when an underextended impression has been made of the posterior lingual pouch (arrowed)



Fig. 3 Well-formed impression of (lower) lingual sulcus area

Impression material	Consistency			Type of tray recommended	Impression type-Primary (1°) or Secondary (2°)
	Viscous	Medium	Light		
	*	*	*		
Impression compound	*			Metal or plastic stock	1° (upper and lower)
Tracing stick (greenstick)		*		Customised resin	2°; 'customises' customised tray
Compound/greenstick admix	*			Customised resin	2° (lower)
Irreversible hydrocolloid		*	*	Stock or customised	1° or 2° (upper mainly)
Modified hydrocolloid ie two-phase system	*		*	Metal or plastic stock	1° (upper and lower)
Polyvinylsiloxanes	*	*	*	Stock for putty, Customised for medium or light phases	1° if putty 2° for medium- and light-bodied phases
Polyethers		*		Customised	2°
Polysulphides		*	*	Customised	2°
Plaster of Paris			*	Customised	2° (upper)
Zinc-oxide eugenol	*			Customised	2° (lower mainly)

Figure 4 illustrates two impressions, using a two-phase hydrocolloid™ (Acudent Research and Development Co. Inc., 85 Industrial Way, Buellton, California 93427, USA), each of which clearly records the denture-bearing area. The gel of the thinner phase is syringed into the sulci and the viscous phase is located onto the tray. In each case, the denture-bearing area is outlined in indelible pencil onto the completed impression; this is to assist the technician when the customised tray is to be made. Impressions should be disinfected, in conformance to local health and safety guidelines, before being cast.

Before dispatching the primary impressions, or the primary casts if the dentist or his dental nurse has cast the impressions, the clinician should indicate to the technician the requirements of each customised tray, eg spacing, presence of handles, etc. In the case of customised trays for complete dentures, we recommend

that the technician does not perforate the trays, as this inhibits the determination of a peripheral seal (*vide infra*).

Template technique

There are occasions when either the patient wishes to have a copy made of his dentures, or the dentist elects to replicate the form of the polished surfaces of the dentures to help the patient's adaptation to the new dentures. Several clinical techniques have been advocated^{3–5} and they share the philosophy of fabricating a mould which contains the denture to be replicated (the template). The material investing the denture to be copied may be irreversible hydrocolloid or silicone rubber of putty consistency. When the denture is removed, wax or autopolymerising resin is poured into the mould to fill the occlusal aspects of the mould. Acrylic resin is then poured into the closed mould via inlets to fill the denture base and the replica denture prepared before definitive impressions (Fig. 5).

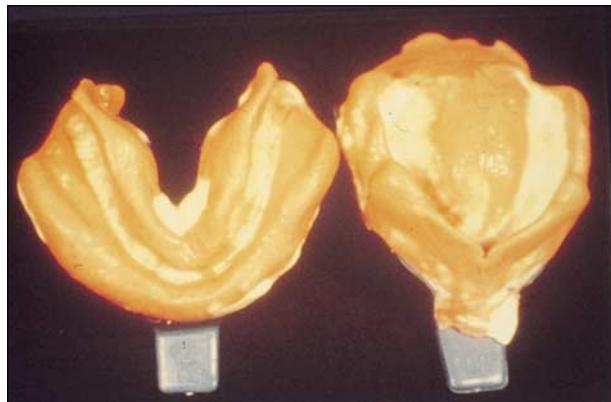


Fig. 4 Two well-formed impressions using a twin-phase hydrocolloid material

Definitive impressions

According to the BSSPD guidelines, definitive impressions 'should record the entire functional denture-bearing area to ensure maximum support, retention and stability for the denture during use.'

The primary purpose of definitive impressions, therefore, is to record accurately the tissues of the denture-bearing areas, in addition to recording the functional width and depth of the sulci. As has been discussed previously, there is a

need for the clinician to determine what type of impression technique is appropriate for each patient as, clearly, the condition of the tissues of the denture-bearing areas and the peri-denture tissues must influence the impression technique selected. The recording of the definitive impression is the keystone of the denture-prescribing process and the practitioner should select the appropriate technique carefully.

To avoid confusion, we shall describe a standard 'conventional' impression technique for upper and lower definitive impressions. In the interests of completeness, we shall also describe a variety of other techniques which may be grouped into the following three groups:

- Selective pressure
- Functional
- Reline and rebase impressions (including secondary template impressions).

Trays for definitive impressions

Primary casts are generally poured in dental stone and should, by virtue of the primary function of primary impressions, be slightly overextended. Depending on the presence, amount and position of undercuts the clinician should outline how much spacing is required between the tray and the primary cast, eg 3 mm spacing is recommended for irreversible hydrocolloids where large undercuts are present.

While most clinicians leave the selection of the tray material to the laboratory, the clinician should advise the technician on the form of the tray. Mention has been made already of the reason for not perforating customised trays for complete dentures prior to establishing a peripheral seal. Similarly, in order that the form of upper and lower labial sulci are not overextended, there is merit in having stub handles that will not distort the lips (Fig. 6).

Conventional impression

- After disinfection of the trays, and subsequent rinsing in water, check that each tray is adequately extended antero-posteriorly and bucco-lingually. If the trays interfere with the function of the peri-denture soft tissues, instability of the completed denture will occur if overextension is not relieved. The extent of the overextension may be determined by pressure-relief paste. Underextension may be corrected by adding tracing compound or a similar material (Fig. 7).
- Apply tracing compound to the posterior aspect of the upper tray to produce a posterior seal. The tracing compound should extend uninterrupted from one border of the tray to the other. This allows the creation of a post dam, facilitates location of the tray posteriorly and, finally, serves as a spacer for the impression material. In the lower tray, the compound should be added to displace



Fig. 5 Copy denture poured prior to modification of both the impression surface and the occlusal surface

the retro-molar pad sufficient to give a posterior seal.

- Add the tracing compound to increase the functional width of one buccal periphery (the impression material will record the functional depth). When completed, the other buccal periphery is recorded (Fig. 8). If required, the labial periphery may be moulded, although this is usually not necessary as much less resorption tends to occur in the depth of the labial sulcus. The lower tray is similarly modified.
- At this stage, the fully customised trays should exhibit good retention, a matter of confidence for both clinician and patient. Also at this stage, perforation of the upper tray may be done at the chairside, to enhance retention of, eg irreversible hydrocolloid and/or to prevent the occurrence of air bubbles being present in the palatal vault.



Fig. 6 stub handles will not distort the lower lip; any distortion is likely to alter sulcular form of the definitive impression



Fig. 7 Addition of tracing compound to a lower tray considered to be underextended distally and posteriorly

- Add a small amount of soft tracing compound or suitable material to the special trays in the region of the upper and lower canines and gently place into the mouth. These, as for the posterior placement, will serve as a spacer and prevent the incorporation of support problems by avoiding undue and uneven displacement of the impression material (Fig. 8).
- Depending on the nature of the ridges and the preference of the clinician, a variety of materials may be selected (Table 2). It is our contention that the critical components of this technique are that a stable and retentive peripheral seal will be established and that appropriate spacing is incorporated; the choice of material, within reason, is of secondary importance.
- Following loading of the tray with the material, we recommend an impression technique similar to that described for the primary impression.
- When each impression has been removed from the mouth, and checked for accuracy and form, it should be subjected to an appropriate disinfection procedure, eg hypochlorite, 1,000 ppm available chlorine.
- Before sending the definitive impressions to be cast, the clinician should carefully indicate the extent of the peripheral roll to be preserved on the master cast (Fig. 9). Given the emphasis placed on creation of the peripheral seal, it would not be desirable to lose this because of faulty master cast preparation.

Fig. 8 Tracing compound added to effect a peripheral seal. Note that some compound has been added on the areas relating to the ridge of the canine areas to act as anterior spacers



Fig. 9 Definitive impression with well-defined area for the placement of carding wax prior to boxing the impression, thereby preserving the functional width and depth of the sulci



Selective pressure impression techniques

In these techniques, three of which are described, there is a need to modify the impression procedures because of perceived support problems, eg displaceable upper anterior (flabby) ridge, fibrous (unemployed) posterior mandibular ridge or flat (atrophic) mandibular ridge covered with atrophic mucosa. While other support problems may be overcome by appropriate relief of the master cast, these conditions are best overcome by modified impression techniques. Several variations of these impression techniques occur and we have attempted to standardise them.

We recommend that the adaptation of the customised trays should be as for a conventional technique and that only after the peripheral moulding has been completed should the modifications to the trays/techniques occur. The three common clinical conditions requiring selective impression techniques are:

- Displaceable (flabby) anterior maxillary ridge
- Fibrous (unemployed) posterior mandibular ridge
- Flat (atrophic) mandibular ridge covered with atrophic mucosa.

(i) Displaceable (flabby) anterior maxillary ridge (see Part 3 Fig. 2)

After ensuring that the peripheral moulding or customising has resulted in a peripheral seal, an impression of the whole maxilla is taken using either zinc-oxide-eugenol (ZOE) or a medium-bodied polyvinyl siloxane (PVS) impression material. The former is not recommended in a patient with a dry mouth, as it tends to irritate the mucosa.

On setting, the impression is removed from the mouth and the extent of the displaceable tissue is drawn on the impression surface. This area, and the equivalent area of the tray, are then removed, using a scalpel and acrylic bur (Fig. 10a) — insertion of this modified impression and tray will demonstrate that the tray is no longer retentive.

Holding the modified tray and impression *in situ*, use a low-viscosity material (Plaster of Paris if ZOE was used, light-bodied PVS if a medium-bodied one was used) and paint or syringe these onto the displaceable tissue to record them in a minimally-displaced position. On setting, it should be apparent that a peripheral seal has been re-established.

This completed impression (Fig. 10b) should then be marked and disinfected as for a conventionally created impression before dispatch to the laboratory.

(ii) Fibrous (unemployed) posterior mandibular ridge

This condition may be recognised by the presence of a thin, mobile thread-like ridge which is essentially fibrous in nature (Fig. 11).

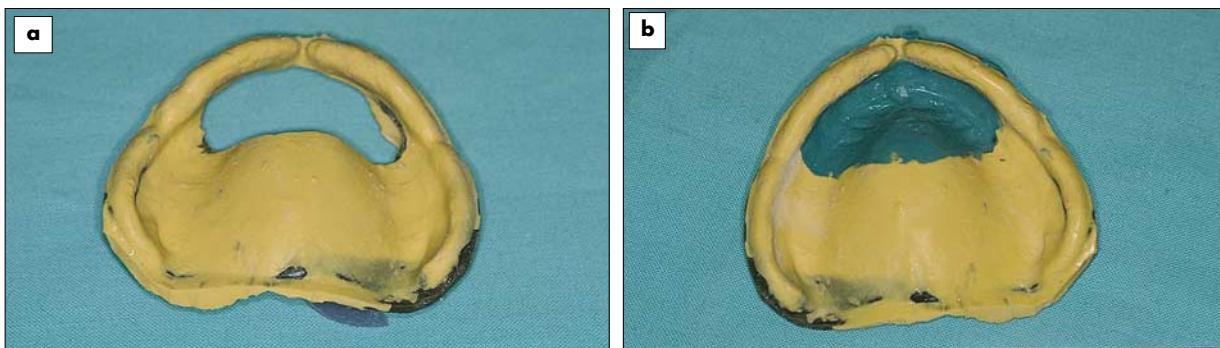


Fig. 10 a) Displaceable area removed from special tray. In this case, a medium-bonded PVS impression was used. **b)** Completed impression. Here a light bodied PVS impression material was syringed onto the displaceable tissue

The technique is shown in Figure 12a–c.

- When the customised tray has been adequately checked for peripheral extension, it is loaded with tracing compound (greenstick) and an impression of the denture-bearing area recorded.
- Using the heated spoon-end of a Le Cron carver or a similar instrument, remove the greenstick relating to the crestal tissues and perforate the tray in this region. Downward finger pressure of the modified impression, in the mouth, should elicit no discomfort.
- Inject some light-bodied PVS onto the buccal and lingual shelves of the greenstick and

gently insert the impression. Excess material will be extruded through the perforations, and the fibrous ridge will assume a resting central position, having been subjected to even buccal and lingual pressures.

The impression is now treated as for a conventionally made impression.

(iii) Flat (atrophic) mandibular ridge covered with atrophic mucosa (Fig. 13)

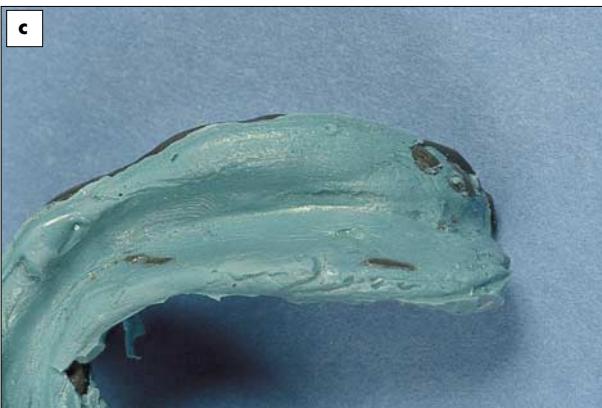
These ridges equate to Atwood's ridge orders v and vi and may be complicated by folds of atrophic and/or non-keratinised tissue lying on



Fig. 11 View of fibrous posterior mandibular ridge. This ridge as such is not useful for support



Fig. 12 a–c Staged sequence of techniques:
a) Preliminary stage using tracing compound; **b)** Crestal area cleared of tracing compound - tray perforated on crestal area; **c)** Definitive impression using light-bodied polyvinyl siloxane



the ridge. McCord and Tyson described this technique which is specific for this clinical situation.⁶ The philosophy is that a viscous admix of impression compound and tracing compound removes any soft tissue folds and smoothes them over the mandibular bone; this reduces the potential for discomfort arising from the 'atrophic sandwich', ie the creased mucosa lying between the denture base and the mandibular bone.

The impression medium here is an admix of 3 parts by weight of (red) impression compound to 7 parts by weight of greenstick; the admix is created by placing the constituents into hot water and kneading with vaselined, gloved fingers.

Using a standard impression technique, the lower impression is recorded. The working time of this admix is 1–2 minutes and this enables the clinician to mould the peri-tray

tissues to give good peripheral moulding (Fig. 14).

On removal, this impression is chilled in water and then re-inserted. The operator presses on the stub handles of the tray on the premolar region and reciprocates with his or her thumbs on the inferior body of the mandible; ideally, discomfort will be felt by the patient in the area pressurised by the operator's thumbs!

Any discomfort in the denture-bearing area may be treated by adjusting the offending area of the impression with a heated wax knife and re-inserting as required until no further discomfort is felt. Alternatively, the clinician could indicate where relief is required on the master cast. This technique gives the clinician a reliable guide to the load-bearing potential of the patient's denture bearing area when making the definitive impression.

Fig. 13 View of atrophic mandibular ridge suitable for admix impression material



Fig. 14 Definitive impression



Fig. 15 Functional impression using a chairside resilient lining material



Functional impressions

These techniques may be used where problems of stability exist, either because of poor muscle adaptation and/or imbalance or because of problems of available denture space. They may also be useful in patients who have recently suffered from a stroke.

Two variations are commonly used for functional impressions.

(i) Local areas of modification

On occasion, dentures may exhibit looseness, not arising primarily from retention problems but because of localised areas of poor functional adaptation. In these cases, the application of a thin mix of a chairside resilient lining material (eg Visco-Gel, Dentsply Limited Surrey UK) may be used. The mixed material is added to the fitting surface of the denture and the patient is instructed to wear the denture for one hour. After one hour of functional moulding the denture is then removed from the mouth (Fig. 15) and the conventional relining process completed.

(ii) Problems associated with denture space/neutral zone

This technique is well documented and has been referred to as the neutral zone technique or anthropoidal pouch technique. We prefer to use the term denture form impression technique. It is designed for patients with poor track records of (lower) denture stability, a large tongue or other anatomical anomaly.

The clinical stages are standard up to and including the registration visit. After this, the upper denture is set up conventionally to the prescribed occlusal vertical dimension (OVD). Opposing the upper set-up is a resin base with three vertical stops joined by a wire bent in a sinusoidal manner (Fig. 16). The stops must contact the upper teeth at the selected OVD.

Helpful Hints

- 1 Carefully survey the denture-bearing area and select a stock tray of appropriate extension. Determine which form of definitive impression is indicated, on the basis of the nature of the supporting tissues/patient's functional requirements.
- 2 Practise the insertion of the tray to enable a) the patient to be aware of what is required in impression making and b) the clinician to be confident of his technique.
- 3 Ensure the technician is aware of the requirements for each tray (eg spacing, handles, lack of perforations, etc).
- 4 Use the impression material that works best in your hands.
- 5 If the impression material is absent over the tissue surface of the tray, a support problem will be introduced to the completed denture.
- 6 Ensure that areas that will require relief are marked on the definitive impression using an indelible pencil.

Polyvinylsiloxane putty is added to the conventional fitting surface and also to the buccal and lingual aspects of the lower base which has been coated with the requisite adhesive, and placed in the patient's mouth. Following this, the upper try-in is inserted and the patient asked to close to the OVD, swallow and carry out closed mouth exercises. These exercises provide an indication of where inward-directed forces from the buccinator muscles are equalled or 'neutralised' by outwardly-directed lingual forces ie the zone of minimal conflict (Fig. 17).

The disinfected functional impression and upper try-in are sent to the laboratory and plaster or laboratory-putty keys made of the functional impression (Fig. 18). Into these keys wax is poured to give a functional form to the polished surfaces and occlusal form of the lower denture. The technician is then required to fabricate the lower try-in and, subsequently the lower denture, to match the functional template — this will necessitate appropriate customising of the occlusal table width and possibly its length.

This procedure is clinically and laboratory technique-sensitive and competence in this technique must be shared by clinicians and technicians if a successful outcome is to be achieved.

Reline and rebase techniques (including secondary template impressions)

Irrespective of whether a conventional relining impression is being taken, or a secondary impression for the template technique, they are both definitive impressions and must be

accorded the same degree of attention as standard impression techniques.

The denture, or replica, to be relined should be modified peripherally to ensure that the peripheral seal has been established.

Undercuts are removed from the impression surface of the denture, to ensure that the master cast is not damaged on removal of the denture (Fig. 19).

Zinc oxide eugenol impression material was generally used here although clinicians now prefer to use polyether, polysulphide or polyvinylsiloxane. Before recording the definitive impression, there is merit in placing tracing compound as spacing on the denture in the region corresponding to the ridges of the canine areas (*see* conventional impression techniques). However, care must be taken to ensure that no unplanned increase on OVD is inadvertently incorporated.

In the case of the maxillary impression, there



Fig. 16 Suggested form of lower 'rim' for denture form impression technique



Fig. 17 Completed functional impression of denture form — recorded in PVS putty

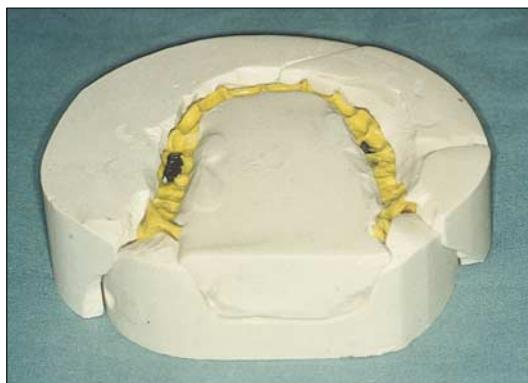


Fig. 18 Plaster of Paris dies or stents of impression of denture form. These enable an exact wax form to be poured

- 1 Basker R M, Davenport J, Tomlin H. *R. Prosthetic treatment of the edentulous patient.* 3rd ed. pp88-93, London: Macmillan, 1992.
- 2 *Guides to Standards in Prosthetic Dentistry — Complete and Partial Dentures. Guidelines in Prosthetic and Implant Dentistry.* Ogden A. (ed) pp 7-11, 1996; London: Quintessence Publishing Company Limited.
- 3 Davenport J, Heath J R. The copy denture technique. *Br Dent J* 1983; 155: 162-163.
- 4 Duthie W, Yemm R. An alternative method for recording the occlusion of the edentulous patient during construction of replacement dentures. *J Oral Rehab* 1985; 2: 161-171.
- 5 Murray I D, Wolland A W. Simple denture copying using the Murray-Wolland duplicating box system. *Dent Tech* 1986; 39: 4-8.
- 6 McCord, J.F., Tyson, K.W. A conservative prosthodontic option for the treatment of edentulous patients with atrophic (flat) mandibular ridges. *Br Dent J* 1997; 182: 469-472.

is also merit in perforating the palate in the midline of the rugae to prevent any possibility of imperfections in the impression, eg air bubbles.

Although this chapter has described impression techniques for a variety of clinical conditions, it has also stressed the importance of good communications with the laboratory. Good rapport between the dentist and technician will ensure quality of all stages in the prescription of dentures.

Conventional techniques, however, do little to inform the technician on the customising of upper record rims. In one system, the Swissedent system (*vide infra*), this is addressed and shall be discussed briefly in the next chapter because the principles involved are soundly based.



Fig. 19 Photograph of a poor reline impression. In addition to the faulty form of the palate (caused by folding of excess material) the undercut tuberosity areas were not relieved — presumably the impression material was attached to the patient's tissues.

5

Registration: Stage I — Creating and outlining the form of the upper denture

J. F. McCord,¹ and A. A. Grant,²

In this section, we address how to customise the upper rim (aesthetic base control) to create the form of the replacement complete upper denture. The use of the facebow is also described.

The clinical stage following the visit where definitive impressions are recorded is that clinical visit often referred to as 'the bite' or occlusal registration stage. While most practitioners and indeed most patients might perceive the *raison d'être* of this clinical episode to be about intermaxillary registration solely, we consider that the three component parts of this clinical stage merit separate consideration. The three component parts are:

- Creating and outlining the form of the upper denture
- Recording of intermaxillary relations
- Selection of teeth.

This chapter will present a step-by-step account of how the clinician may develop and customise the upper rim to create a (replacement) prosthesis which conforms to the facial contours and dental/peri-denture constraints, while taking cognisance of the patient's age and denture expectations.

Succeeding chapters will address the record-

ing of intermaxillary relations and tooth selection respectively.

In clinical practice, dentists receive upper wax rims that are duly moulded into the form of the upper denture at the chairside. The precise form of the upper wax rim or block depends, essentially, on how the technicians were taught. In essence, considerable variation probably exists among technicians with regards to the positioning of the labial face of the rim. The consequence of this is that it is often a matter of chance that wax has to be removed or added to the upper rim. In an attempt to save clinical time, and at the same time render the upper rims more appropriate in form for each patient, two techniques have evolved: the biometric technique and the Swissdent technique. Both will be described for interested practitioners and their technicians, as they both have the advantage, in theory, of saving chairside time.

Watt and MacGregor outlined the principles of 'biometric' guidelines to help compensate

In this part, we will discuss:

- Philosophies of restoration of the 'dental bulge'
- Technical aspects of rim preparation
- Clinical stages of determining the form of the upper rim
- The facebow transfer record.

Fig. 1 Photograph of an edentulous maxilla. The cord-like structure was referred to as the remnant of the lingual gingival margins



Table 1

Average values of maxillary labial/buccal bone loss following tooth extraction. The values on the right hand column indicate by how much the labial/buccal faces of maxillary rim are built out from the LGM remnants

Tooth position	Average horizontal bone loss
Incisor	6.5 mm
Canine	8.5 mm
Premolar	10.5 mm
Molar	12.5 mm

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for facial changes following tooth loss, predominantly in the maxilla.¹ In essence, they advocated that the replacement upper teeth be placed in mean pre-extraction positions; these averages were determined over a 30-month period in a group of patients rendered edentulous. The 'fixed' points of reference taken for measurements were the remnants of the lingual gingival margin (LGM) (Fig. 1). Average values for maxillary teeth of replacement dentures are shown on Table 1.

The biometric principle

The biometric principle has much merit in that it helps to compensate for post-extraction bone loss by placement of the denture teeth in perceived pre-extraction positions. A further advantage of placement of the maxillary (denture) teeth labial/buccal to the residual ridge is that this promotes lower denture stability. The placement of the upper posterior teeth buccal to the maxillary ridge, in addition to compensating for the resorption pattern of the maxilla, also means that their palatal cusps may be placed over the mandibular ridge crest. In practice, the palatal cusps will therefore occlude into the central fossae of the lower posterior teeth, thereby directing occlusal forces onto the residual ridge. In addition, this placement of the lower teeth over the lower ridge tends to avoid constriction of tongue space. Perhaps the principal deficiency of the biometric principle is

that it does not necessarily customise the denture form for each patient, nor does it cater for biological ageing. A second problem with this philosophy is that anatomical features not dissimilar to the remnants of the lingual gingival margin have been observed in patients suffering from anodontia.

Another technique which helps customise the upper rim is described in the Swissedent technique.² This technique, which was referred to in the previous chapter, relies on close and unambiguous communication between the clinician and the technician. It uses two distinct measurements for each patient in order that the upper rim (termed the aesthetic control base [ACB]) may be customised for each patient. These two measurements are related to the patient's facial form and are taken immediately after the definitive impressions have been recorded and are dispatched along with these impressions to the laboratory.

The first measurement is taken via what is called the papillameter (Fig. 2). The procedures to be followed for the papillameter reading are as follows:

- Place the papillameter inside the patient's upper lip and let it rest on the incisive papilla.
- Add addition-cured polyvinyl siloxane (PVS) putty to the papillameter and mould the upper lip to restore the vermillion border. In younger patients, the philtrum may be restored but this may not be possible in older patients (Fig. 3a).
- Determine how much of the upper incisor will be shown under the upper resting lip length (*vide infra*).
- Level the PVS at the incisal level and record the reading from the graduated scale on the papillameter (Fig. 3b).
- The customised papillameter is sent to the laboratory and this enables the technician to have sufficient information to prepare an upper rim that provides upper lip support. Patient information, eg from photographs or via dentures favoured by the patient may

Fig. 2 The papillameter is a simple gauge with a step on its inner aspect; this step rests on the incisive papilla and the graduated column rests between the labial aspect of the ridge and the lip. The graduation commences at the level of the incisive papilla and the clinician determines where the incisal tips of the maxillary incisors will lie in relation to the resting lip level and records the reading appropriately from the graduated scale.

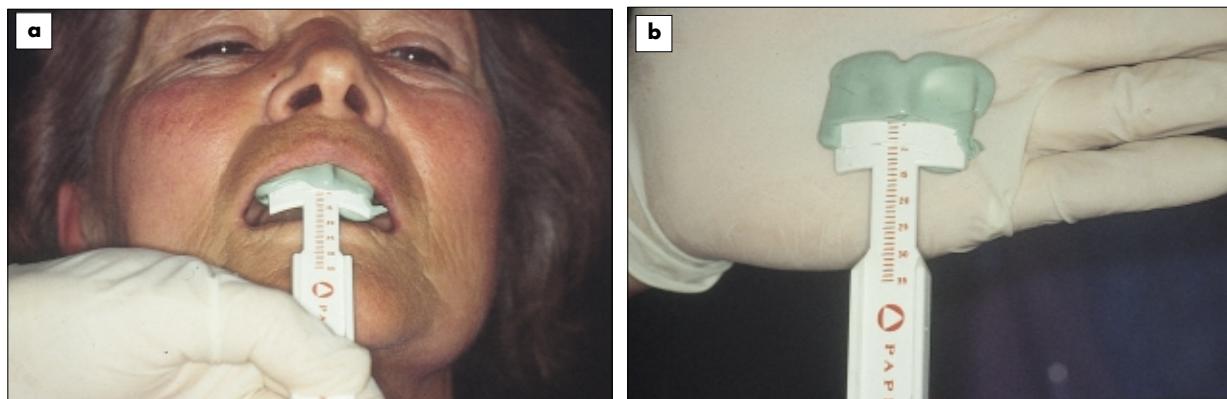


Fig. 3 a) Papillameter *in situ* with PVS putty used to restore the form of the upper lip;
b) The incisal point is indicated on the papillameter 'Plimsoll-line'.

also be used to help determine the upper lip form which is well perceived by the patient. Equally, the Alma Gauge³ (Fig. 4) may be used to produce an upper rim (ACB) with equivalent dimensions, labially, to previous or current dentures that are considered adequate. In essence, the Alma Gauge comprises a graduated table and a spring-loaded pointer that is also graduated. The denture being 'templed' is placed on the graduated table and the pointer placed in the impression surface of the denture in the middle of the area occupied by the incisive papilla. The distance from the pointer to the incisal tip of the central incisors may be read off the (horizontal) graduated scale on the table. The vertical distance from the pointer tip to the incisal tips is then read off the graduated scale, giving a three-dimensional reading from the incisive papilla to the incisal tips of the central incisors.

The second measurement concerns the anterior width of the upper rim and for this a calliper-like device called an alameter is used. The alameter's usage is based on a reasonable clinical guideline, namely that the width (ie horizontal distance) between the alar cartilages in a smiling patient is broadly speaking comparable to that of the canine tips (Fig. 5). This reading enables the technician to evaluate the width of the upper rim, assuming that there is symmetry about the palatal midline.

Preparation of the upper rim

Upper rims comprise bases and rims. The bases may be made of wax, thermoplastic

resin or of (poly) methylmethacrylate (PMMA) while the rims are generally made of wax. Table 2 lists some of the materials, which may be used as bases for recording rims, with indications of effectiveness. In general, bases for occlusal rims/aesthetic control should be:

- Well adapted and conform closely to the master cast
- Stable, on the cast and *in situ*
- Free of voids or surface projections on the impression surface
- No more than 1 mm thick over the residual ridge to prevent the base interfering with the placement of the denture teeth
- 2 mm thick in the post dam area of the maxillary denture (and 2 mm thick in the lingual flange of the mandibular denture) to impart rigidity
- Easily removed from the cast
- Smooth and rounded so as to reproduce the contours of the master cast
- Constructed in materials that are dimensionally stable at oral temperature.

As wax bases do not provide stability *per se*, their usage is not encouraged. Thermoplastic resins tend to be brittle and, as they lack the versatility of PMMA, they no longer enjoy widespread usage in clinical or laboratory practice.

Depending on the preference of the clinician and/or the technician, bases may be made of auto-polymerised PMMA, light-cured PMMA or processed PMMA; all provide adequate potential stability although they vary in their

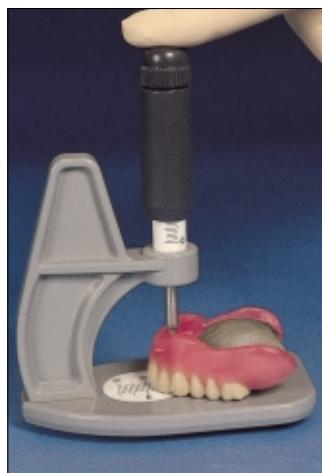


Fig. 4 The Alma Gauge which may be used to record the horizontal and vertical relationships of the incisive papilla landmark on the denture to the incisal points



Fig. 5 Facial view of dentate subject indicating the relationship between the canine tips and the alar cartilages

Table 2 Common materials used as bases for record rims			
Classification of base	Material	Advantages	Disadvantages
'Temporary' bases	a. Thermoplastic resin	Cheap, easy to adapt to cast, easy to adapt to post dam on master cast	Brittle, may fracture in clinical use.
	b. Auto-polymerised PMMA	Cheap, technicians familiar with usage	Acceptable material but handling problems possible
	c. Light-cured PMMA	Easy to make tray, quick technique	Problems of adherence of wax to base, polishing more difficult than b (above).
	d. Vacuum-formed (PVA)	Fast, quite cheap, not messy	Requires thermal vacuum machine
	e. Baseplate wax	Cheap, easy to adapt	Easily distorted
'Permanent' bases	a. Processed resin	Rigid, accurate and stable bases — become part of final denture	Destroys master cast, good clinical and technical techniques required
	b. Cast alloys eg gold, cobalt-chromium	Bases are rigid, stable and should have accurate fit	Cost more than other types, especially gold alloys. Sound impression techniques required, especially in post dam area. NB a conventional wax try-in should be performed first to establish the planned positions of the denture teeth.

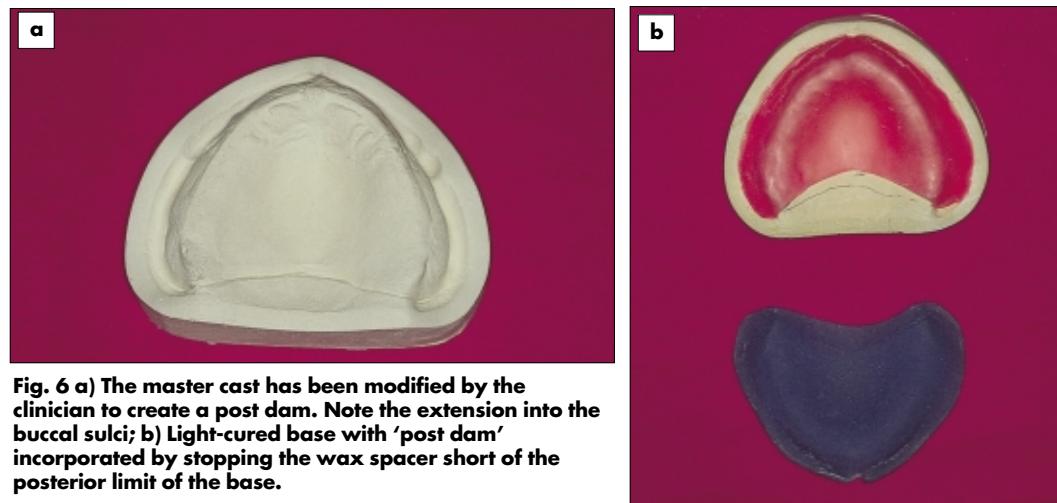


Fig. 6 a) The master cast has been modified by the clinician to create a post dam. Note the extension into the buccal sulci; **b)** Light-cured base with 'post dam' incorporated by stopping the wax spacer short of the posterior limit of the base.

levels of tissue-fit. In theoretical terms, however, the processed bases tend to be superior.⁴

Technical aspects of rim preparation

Unless the clinician has cast the definitive impression and has scored the master cast to define the post dam (Fig. 6a), the rim will not exhibit a clinically-meaningful peripheral seal. This may be achieved by the technician relieving the master cast in 1 mm wax, but stopping this relief 2 mm short of the vibrating line, thereby incorporating a form of post dam inherent in the denture base. The clinician must be aware however that this would not

conform to the anatomy of the tissues comprising the patient's post dam (Fig. 6b). It would, however, provide an acceptable peripheral seal as long as the functional width and depth of the sulci were faithfully restored in wax.

Using the papillameter and alameter readings, the anterior aspect of the rim may be customised, in wax, to permit early visualisation of the aesthetic form of the upper denture. The alameter reading further helps the technician customise the rim by establishing the (horizontal) inter-canine distance customised for each patient.

The posterior aspect of the rim is also made of wax and resembles conventional record rims (Fig. 7).

Clinical stages in determining the form of the upper rim

There are eight clinical stages, these are described below:

- Before immersing the rim in disinfectant material, in keeping with conventional infection control procedures, and prior to inserting the rim into the mouth, the clinician should ensure that the rim is well adapted to the master cast. Alternating finger pressure on each side of the rim should

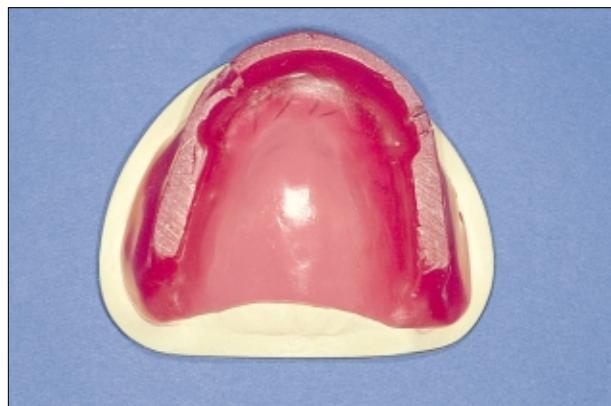


Fig. 7 Occlusal view of upper rim (aesthetic control base)



Fig. 8 The form of the lip at the height of the labial sulcus has been distorted. This will affect the position of the resting lip length by raising the lip inappropriately



Fig. 9 Appropriate lip support has restored the vermillion border; the philtrum, however, has not been restored

not elicit a rocking of the rim on the cast.

- When the rim has been inserted into the mouth and the clinician has ensured stability of the rim, the first clinical step is to ensure that the infra-nasal tissues are harmonious with the soft tissues of the middle third of the face. Failure to do this may affect the form and length of the upper lip (Fig. 8), by raising the lip inappropriately.
- Confirm that the upper lip is adequately supported. This should result in restoration of the vermillion border and may result in restoration of the philtrum although, as has been mentioned, this may not always be desirable or possible (Fig. 9). Some clinical guidelines recommend that the vertical naso-labial angle should be 90°, although recent research casts doubt on the validity of this guideline.⁵
- When the upper lip has been restored appropriately for the patient, it is then practical for the clinician to determine the position of the incisal point relative to the resting lip. While some textbooks recommend that the incisal level of the upper rim is 2 mm inferior to the resting upper lip, the clinician should temper this by deciding what is appropriate for each patient. Younger patients may reasonably be expected to show 4–5 mm of tooth beneath the resting lip, especially if the patient had a Class 2 division 1 profile. In contrast, a 70-year-old patient might be best suited by having the incisal point level with the resting lip, or possibly 1 mm above this (Fig. 10). Antero-posterior verification of the placement of the incisal point may be achieved by asking the patient to say a word containing a fricative consonant (labiodental sound) eg ‘fish’; in general terms, the incisal point should correspond to the vermillion border of the lower lip.⁶
- The next step in this clinical exercise is to determine the upper anterior plane. Given the position of the incisal point, the plane of the upper six anterior teeth is usefully determined by making it parallel to the inter-pupillary line. This may be done using a Fox’s occlusal plane guide (Fig. 11) or any device giving a horizontal plane eg a wooden spatula.

When this has been performed, there is merit in determining the position of the mid points of the upper canine teeth. One useful way to record this is to use a photograph of the patient when the patient was dentate. A clear, face-on photograph is required for this and, regrettably, these are not always available. Using the pupils as stable reference points, the clinician may determine the relative position of the upper canine teeth using the ratio shown in Table 3.

This simple mathematical model, using different terms, is often used in endodontics to

Table 3

Ratio to help determine inter-canine width

$$\frac{\text{Actual interpupillary distance}}{\text{Actual intercanine tip distance}} = \frac{\text{Photographic interpupillary distance}}{\text{Photographic intercanine distance}}$$

determine the working length of a root canal.

A second useful technique is to extend dental floss from the inner canthus of the eye, via the lateral border of the alar cartilage (with the patient smiling) onto the incisal edge of the upper rim (Fig. 12).

Using the canine points on the upper rim as reference points, the right and left posterior planes are formed. The accepted guideline is that this plane is parallel to the line drawn from the inferior border of the alar cartilage to a



Fig 10 This slide of a smiling dentate septuagenarian illustrates the fact that the upper central incisors would be level with, or just above, the upper resting lip



Fig. 11 A reasonable guideline for the upper incisal plane is parallel to the inter-pupillary line



Fig 12 The use of dental floss to determine the position, on the ACB, of the mid-point of the canines

position two-thirds of the way up the tragus (Fig. 13).

Again using the mark on the rim corresponding to the canine tips as a reference point, the buccal form of the upper rim may be moulded by reducing the inferior borders of the posterior rims by 3° to 5°. This procedure creates what are known as the buccal corridors and creates a more natural smile (Fig. 14).

Before completing the customising of the upper rim, the following should be scribed clearly on the anterior aspect of the rim (Fig. 15):

- Centre line
- High smile line
- Canine points.

The significance of these points will be made clear in Part 7.

With the upper rim *in situ*, ask the patient to smile; the upper rim should appear to be parallel to the lower lip line when smiling (Fig. 16).

The posterior border of the upper denture should displace the mucosa overlying the aponeurosis of tensor palati at the junction between the hard and soft palates. As the details of the displacability of the tissues of the post dam are known only to the clinician, it is the sole responsibility of the clinician to scribe the

appropriate extent and depth of the post dam using eg a Le Cron carver or similar instrument (see Fig. 6a); if not done so prior to this stage, the clinician should ensure that he/she scribes the post dam appropriately.

Depending on the occlusal and stability requirements of the patient, the clinician may consider it necessary to use a facebow to transfer the relationship of the upper rim to an arbitrary hinge axis. Although it must be conceded that it may not always always be strictly necessary to use a facebow in all complete upper denture cases, we are now of the opinion that we cannot think of a valid reason not to use a facebow in the prescription of complete dentures. We firmly believe, however, that clinicians should consider the use of a facebow especially when a complete upper denture is opposed by a natural dentition or an implant-supported overdenture.

As the authors use a Gothic-arch tracing device (Fig. 12, Part 6) to record intermaxillary relations, we use a facebow transfer at this stage. For those practitioners who use upper and lower rims, the facebow transfer should take place after the lower rim has been adjusted to vertical, antero-posterior and coronal requirements.



Fig. 13 Fox's plane used to help assess the orientation of the posterior occlusal plane. Note that, in this case, the plane dips posteriorly — this would result in occlusal problems



Fig. 14 Creation of buccal corridors on the upper ACB — the incorporation of these will create a more natural and more aesthetic smile. In this slide, the buccal corridor on the patient's right has been incorporated

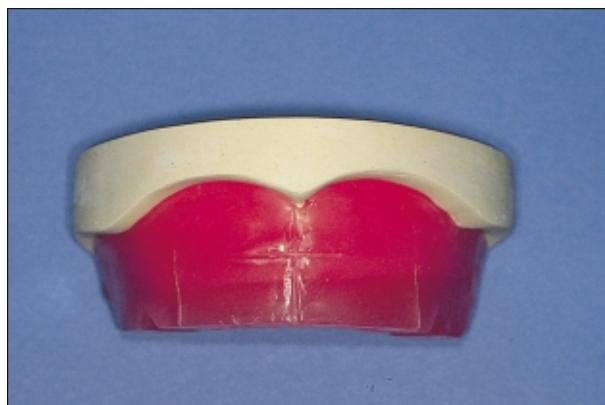


Fig. 15 Upper rim/ACB indicating dental landmarks



Fig. 16 The occlusal surfaces of the ACB should be parallel to the smile line

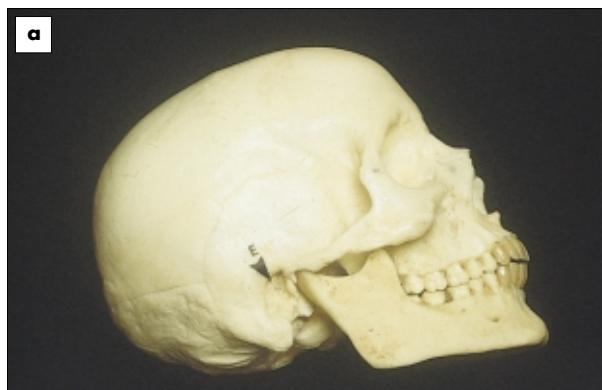
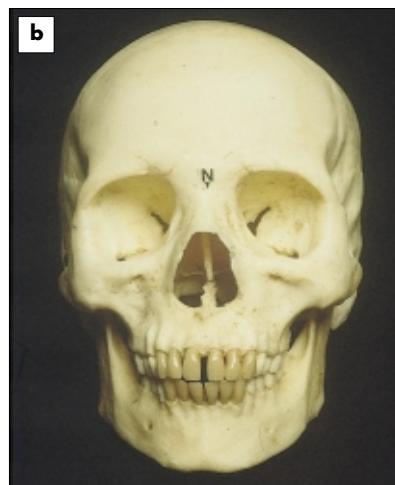


Fig 17 Two of the three points used to transfer the maxillary plane. a) E, External Acoustic Meatus; b) N, Nasion



The facebow transfer record

The facebow transfer, in this context, is used to transfer the relationship of the maxillary plane to the intercondylar axis on the patient. Once established, this relationship is transferred to the articulator in order that the casts of the edentulous maxilla assume the same relationship to the articulator's intercondylar axis. For complete denture work, a hinge axis facebow is not required and a simple facebow using an arbitrary axis will suffice.

In essence, a facebow is a calliper-like instrument used to record the spatial relationship of the maxillary arch to the temporomandibular joints and then transfer this relationship to an articulator; it orients the (maxillary) dental cast in the same relationship to the opening axis of the articulator. Customarily the anatomic references are the mandibular condyles' transverse axis and one other selected anterior point.⁷

In essence, a facebow consists of three components, a facebow fork, an anterior locator and a U-bow used to locate the condyles (the two posterior determinants).

As was mentioned earlier, the principal purpose of the facebow is to record the relationship of the patient's maxillary plane to the patient's transverse condylar axis and then transfer that relationship to the articulator. To transfer that plane, therefore, three points must be transferred. In practice, two are located posteriorly, to record the arbitrary transverse axis, and one anterior landmark (Fig. 17a and b).

We recommend the use of a facebow transfer record simply because this ensures that the plane of the upper complete denture will be better aligned to the condyles and thus to the mandibular arch during mandibular movements. This is particularly important when complete upper dentures are opposed by a natural dentition (or a natural dentition plus a lower partial denture) as displacing forces on the upper denture may be profound. Without the facebow transfer, technicians tend to set up the upper rim parallel to the worktop; most

patients do not walk around with their maxillary planes parallel to worktops. Clearly if the patient only exhibits vertical chewing movements, facebow transfers are not strictly necessary and because of this not all dental schools in the past taught their usage, although this practice would appear to be changing.

There is a range of facebows available, and the authors are not aware of any evidence stating that one is better than another; we believe that practitioners should be encouraged to use the system with which they are familiar and which is compatible with the articulator used by the laboratory/clinician.

The system demonstrated here is the Denar system and the reader will note that the



Fig. 18 Denar facebow plus forks



Fig. 19 Facebow fork *in situ* in ACB

- 1 Watt D M, MacGregor A R. *Designing Complete Dentures* 2nd Ed. pp 2-31, Bristol: Wright, 1986.
- 2 McCord J F, Gill M, Lee C, Richmond R. *Creating Better Dentures. J Inst Br Surg Tech In Print*.
- 3 Grant A A, Heath J R, McCord J F. *Complete Prosthodontics: Problems Diagnosis and Management* pp52-53. London: Mosby Wolfe, 1994.
- 4 Morris H F. *Recording Bases and Occlusal Rims in Essentials of Complete Denture Prosthodontics* 2nd Ed. Winkler (ed) pp 123-136, St Louis: Mosby, 1988.
- 5 Brunton P A, McCord J F. An analysis of nasolabial angles and their relevance to tooth position in the edentulous patient. *Eur J Prosthodont Rest Dent* 1993; 2: 53-56.
- 6 McCord J F, Firestone H, Grant A A. Phonetic determinants of tooth placement in complete dentures. *Quint Int*, 1994; 25: 341-345.
- 7 The Academy of Prosthodontics. Glossary of Prosthodontic Terms. *J Prosthet Dent*, 1994; 71: 72.
- 8 Denar Slidematic *Facebow Instruction manual* Teledyne Water Pik Fort Collins Colorado USA.

posterior points are ear pieces and the anterior point is located 46 mm superior to the anterior rim of the ACB.⁸ This measurement is arbitrary and is, conveniently, the mid point between the upper and lower arms of the articulator, hence there should be space in the articulator to accommodate both casts.

In all types of transfer bow, for edentulous patients, the bite fork of choice is an edentulous facebow that should not therefore alter the form of the occlusal and incisal edges of the ACB (Fig. 18). This means that for practitioners using the conventional upper and lower wax rim technique, this means that the edentulous facebow may be used.

This step completed, the clinician may now progress to recording the appropriate intermaxillary relations.

Helpful Hints

- 1 Ensure rims are stable a) on master cast b) *in situ*
- 2 Ensure the master cast is scored appropriately in the post dam region and that areas requiring relief are identified on the master cast (clinician's responsibility) or that relief has been placed (usually technician's task).
- 3 Ensure upper labial lip form is appropriate — this will influence the location of the incisal point.
- 4 Check that the occlusal edges are in accordance with prosthodontic guidelines.
- 5 Consider the use of a facebow — technicians normally tend to set up complete maxillary dentures with the occlusal plane parallel to the workbench; not all patient's occlusal planes are parallel to the horizontal!

6

Registration: Stage II — intermaxillary relations

J. F. McCord,¹ and A. A. Grant,²

In this section, various methods of recording of intermaxillary relations are discussed, as is the determination of appropriate occlusal vertical dimension. Consideration is also given to choice of articulator.

In this part, we will discuss:

- How to determine FWS
- How to relate the mandible to the maxilla at an appropriate OVD in RCP
- How to record other intermaxillary relations
- A range of articulators

Recording the jaw relations is a very important procedure in the production of complete dentures. An error at this stage can result in dentures that are uncomfortable, or unwearable, and may even have the potential to produce lasting damage to many elements of the stomatognathic system.

The intermaxillary relations are, of course, three-dimensional. In order to simplify the recording of jaw relations it is established practice, based on extensive clinical practice and current physiological knowledge, to consider three elements. The first of these is in the vertical plane to establish the amount of jaw separation, while the second and third relate to the horizontal plane (which is concerned with the anteroposterior relations) and the coronal plane when one considers the lateral relations of the jaw.

The vertical relationship

Individuals who have their natural dentition demonstrate a space between the occlusal surfaces of the teeth of the opposing jaws when they are at rest and with the head upright. This space, the freeway space (FWS) or interocclusal distance, is determined by a balance between the elevator and depressor muscles attached to the mandible, and the 'elastic' nature of the surrounding soft tissue in a natural dentition. It is usually measured indirectly by noting the difference between the resting vertical dimension (RVD) of the face using, for example, a Willis gauge, and subtracting from this the vertical dimension of occlusion (OVD) with the teeth in occlusion (Fig. 1).

A similar set of circumstances is considered to exist in the edentulous patient — although

the RVD may differ from that which pertained when natural teeth were present. It is now known that the RVD is not a stable position throughout life for a given individual.

However, the RVD may be considered as a factor when determining as to whether a patient will be able to tolerate wearing dentures without intra-oral tissue damage occurring. RVD should also be taken into account as an important aspect of the appearance of the denture-wearing patient. For these reasons it is the starting point from which the OVD is estimated.¹

Because of the role played by the 'elastic' properties of the soft tissue environment of the mouth, the importance of developing the form of the upper denture as described in Part 5 is emphasised. This must be done prior to determining the RVD for the edentulous patient. The weight of the soft tissues attached to the mandible plays a very important role in the RVD as does the position of the head. Tilting the head backwards pulls the mandible away from the maxilla, and a forward inclination pushes the mandible and attached structures closer to the maxilla.

Resting vertical dimension (RVD) measurement
Many methods have been advocated for the measurement of the RVD. These include various facial measurements, swallowing methods, biting force measurements, phonetic methods, tactile methods and electromyographic measurements.

We recommend a combination of some of the above for a simplified clinical determination of RVD.

Two measuring points are required in the midline of the face — one related to the nose,

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Fig. 1 The difference between RVD and OVD

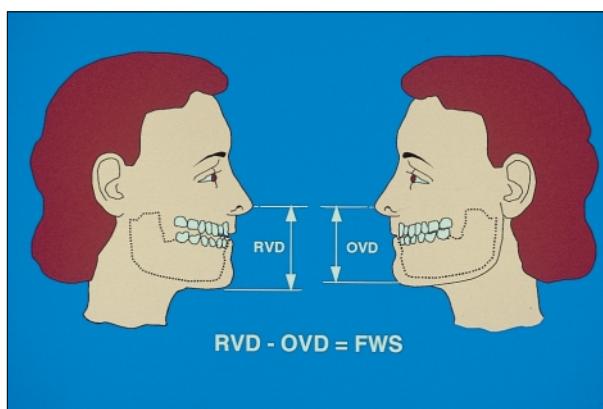


Fig. 2 Willis bite gauge, and a similar instrument, both with an integrated scale, may be used to measure RVD and OVD

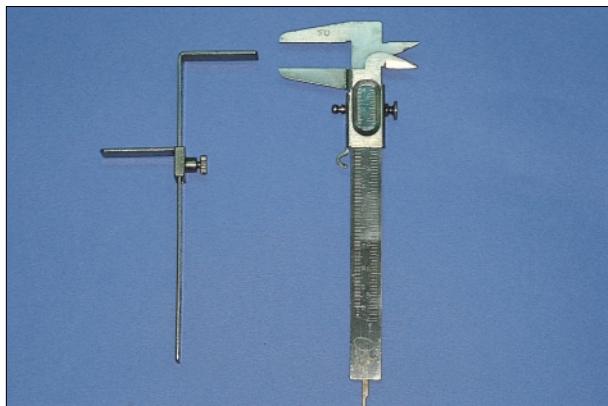


Fig. 3 Excessive OVD results in the orbicularis oris muscle group straining to effect a seal



Fig. 4 Insufficient OVD may result in an ageing effect of the patient's

and one to the chin. These points must be on sites of minimal influence from the muscles of facial expression to avoid skin movement, and should be chosen only after careful observation of the patient seated normally in the dental chair with the head erect. The measurement is made with the patient in a relaxed and comfortable position, while wearing the previously developed upper base and rim. A Willis bite gauge may be used for the measurement, as it incorporates a suitable scale (Fig. 2) or a pair of dividers and an additional scale can be used.

It may be helpful if the patient moistens the lips with his or her tongue and brings them into light contact prior to recording the measurement. Asking the patient to swallow and relax the jaws is also a useful method. Verification of the measured value can be attempted by asking the patient to say the letter 'm' and to hold the facial expression whilst the measurement is made. The general appearance of the patient's face and its proportions should also be taken into account. Careful observation to guard against unwanted skin movement should be maintained during the recording of measurements.

In conventional techniques, once the RVD has been established, the upper and lower bases and rims are placed in the mouth after the upper rim has been moulded (*see Part 5*). The lower rim is reduced in height (usually — or added to if undersized), until it contacts evenly the upper rim at a vertical dimension of occlusion some 2–4 mm less than the established RVD. This provides for a freeway space of 2–4 mm, and establishes the OVD.

In establishing the height of the lower rim, the relative height of both the upper and lower rims should be considered. As a practical consideration, an element of reasonable balance between the two rims is desirable. Excessive height of the lower rim can have the effect of 'walling in' the tongue causing a resultant unstable lower denture. On the other hand, deficient depth of the lower rim can result in poor aesthetics and, further, may result in tongue biting. Conventional wisdom, however, would indicate that the

occlusal plane should be below the dorsum of the tongue at rest.

Errors in OVD

Provision of an appropriate OVD is important because of the consequences which can stem from an over- or under- estimation of this value.

Excessive OVD may result in increased risk of trauma to the tissues underlying the dentures as the absence of a freeway space effectively causes continuous clenching of the teeth. Painful mucosa over the denture bearing areas and muscle soreness, particularly associated with the masseter muscle, may become evident. The teeth are liable to contact (causing clicking) during speech and other speech problems caused by difficulty in bringing the lips together (eg 'p', 'b' and 'm' sounds) may occur. Poor aesthetics may be apparent and there is a possibility of temporomandibular joint dysfunction developing (Fig. 3).

Where there is an under-estimation of OVD, lack of support of the angles of the mouth (causing dribbling and possibly angular cheilitis) may be apparent. Masticatory efficiency may be reduced and poor aesthetics, because of a lack of adequate support of the lips and cheeks may be seen. Chin protrusion on closure of the jaws may also occur (Fig. 4).

Care at this stage is required, and, furthermore, it must not be assumed that the value selected is immutable, as the generally quoted value for the freeway space (FWS) is an average one and, as such, it should be appreciated that some patients may require a larger, or smaller, value. For example, where atrophic mucosa exists in a middle-aged adult an increased FWS might prevent/reduce trauma to the residual mandibular tissues (Fig. 5).²

There are several accepted tests which can be applied to verify the established OVD. However, occlusal rims are so different from the form of teeth to be used that it is very difficult to apply tests for suitability of the chosen value at this stage. Further checks on the established OVD will need to be made at a later stage of denture production — the trial stage — and will be dealt with in Part 8.

Registering the intermaxillary relations

The generally agreed position for recording the antero-posterior position of the mandible relative to the maxilla is that of the retruded contact position (RCP). The reasons for this are first that it is a reproducible position in the edentulous patient. Secondly, abnormal contact between opposing dentures when set up in other than the retruded relationship results in denture instability. Next, the apparatus used for reproducing relevant jaw movements (the articulator) operates from the retruded position, and abnormal temporo-

mandibular joint activity may result from patients attempting to accommodate incorrect occlusal relations.³

Following adjustment of the occlusal rims to the selected OVD, the rims should be inserted into the mouth and the patient persuaded to close gently with the mandible in the retruded jaw relationship. The word 'bite' should not be used, as this suggests to the patient that forceful closure is required and will result in a mandibular position that is protrusive.

A number of methods have been suggested to assist the patient to achieve retrusion of the mandible. Some patients have the capacity to relax the muscles attached to the mandible so that the operator can readily move the mandible up and down as it rotates about the condyles. In those circumstances, the mandible is in the retruded position, and can be guided there during the registration procedure. Other patients are able to retrude the mandible when the tongue is curled back in the roof of the mouth to feel the posterior border of the upper base, or a shallow ridge of wax placed on the palatal area of the base posterior to the first molar region.

In our opinion, the most positive and successful method is by means of the Gothic-arch (or arrowhead) tracing method, as it readily identifies the most retruded position of the mandible relative to the maxilla from which lateral excursions can be made.

Methods of registration

Recording the retruded contact position (RCP) requires upper and lower rims to be fixed in position with the mandible in its most retruded position and with the jaws separated by the established OVD.

A variety of methods for securing a record of the retruded jaw relations (RJR) have been used with varying degrees of success.

These include:

- Wax squash bite (and its predecessor, the T-block system) (Table 1)
- Wax rims or 'Manchester' blocks (Table 1)
- Intra-oral tracing (Gothic-arch tracing) (Table 1)
- Extra-oral tracing.

Wax squash bite

The wax squash bite involves placing a horseshoe shaped roll of softened wax between the upper and lower rims and having the patient close the jaws together. The lower rim is first reduced in height to provide space for the wax. Results using this method are uncertain because of the lack of control of the vertical dimension, the common difficulty of obtaining mandibular retrusion, and the fact that the record takes no account of mandibular movements other than the final act of closure (Fig. 6). In addition, if the wax wafer is not uni-

Table 1 Summary of relative efficiency of registration techniques for complete dentures	
Method	Comments
Squash bite	Poor control over OVD, no control of mandibular movements, or of stability of bases, uncertainty of RCP.
Wax rims including Manchester bases	Good control of OVD, good base stability if PMMA used. Uncertainty of RCP, good occlusion development with facebow mounting.
Intra-oral tracing	Good control of OVD, good base stability, good control of RCP and other mandibular activity. Excellent occlusion and articulation development with facebow mounting.
NB If, after any of the three techniques have been used, the casts are approximated and examined and the heels are found to contact, then this gypsum contact should be removed prior to articulation otherwise a posterior bite will be incorporated into the set-up and will be evident at the trial insertion.	

formly softened throughout its length, an unstable relationship with the underlying tissues is recorded. An earlier version of this method was the T-block method, in which a T-shaped wax form was used instead of the simpler horseshoe form (Fig. 7). The 'horizontal' portion was placed between the rims while the 'vertical' part that protruded anteriorly was intended to be moulded to provide a form of contouring of the labial aspects of the rims. This method fell into disuse because of the arbitrary nature of the moulding procedure that also induced the patient to assume non-RCP posturing of the jaw, as well as having the same defects as those mentioned above.

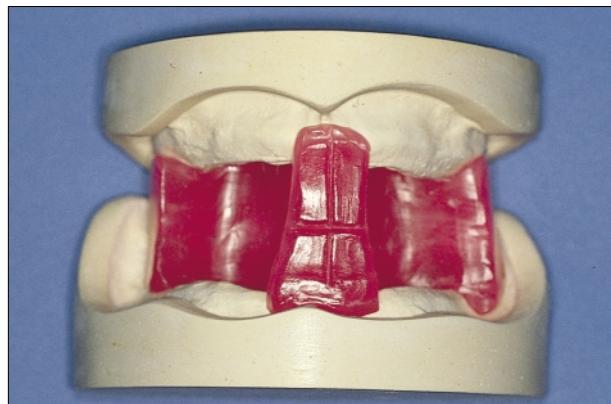


Fig. 5 Atrophic mucosa: an efficient masticatory apparatus with an optimal FWS might result in trauma to the mandibular ridge — intentional increase in FWS might reduce trauma to the denture-bearing tissues of the mandibular denture



Fig. 6 Typical example of squash bite — insufficient definitions of denture geometry and form are prescribed

Fig. 7 T-block precursor to the squash bite and popular at the onset of the NHS



Wax rims

The conventional method that has a higher degree of success also involves the use of wax interposed between the rims to secure a registration. When the upper rim (aesthetic control base [ACB]) has been formed, and prescribed to suit the patient, the lower rim is placed in the mouth and trimmed until it contacts the upper rim evenly in RCP, at the selected OVD. This is done by selectively removing points of first contact. These large wax rims may pose problems in inexperienced hands. Even in experienced hands it is not always easy to detect premature contacts along the lengths of the rims bilaterally.

For these reasons, a simplified lower rim has been developed in the University Dental Hospital of Manchester. It contains several elements

incorporated to ensure that the carefully established OVD is maintained, and that the bases are maintained in stable relationship to the underlying tissues during the procedure. The lower base has attached to it two pillars of wax which are situated in the region of the 2nd premolar/1st molar teeth positions (Fig. 9a and b). When the contacts, bilaterally, are even at the selected OVD, the rims may be sealed with registration paste or other such medium as regularly used.

This method using pillars attached to the lower base — which we call the Manchester block method — provides control over the OVD, ensures a stable relationship between the bases and the underlying tissues, and also provides a record that can be simply returned to the mouth to verify its accuracy. To obtain a functional impression of the labial component of the lower arch, carding wax, Plaster of Paris or PVS putty may be attached to the labial aspect of the rim and a closed-mouth impression used to determine the anterior denture-spaced form.

However, the drawbacks of this procedure comprise uncertainty of achieving the most retruded mandibular position, as well as a lack of information on eccentric mandibular movements.

Intra-oral tracing

Our preferred method of obtaining a consistent position of retrusion together with recognition of mandibular movement other than the final point of closure, is by means of an intra-oral tracing — often referred to as a Gothic-arch tracing. This method is based on rotation about the condyles when lateral mandibular excursions are made. When the mandible moves to the left from a central position, it rotates about the left condyle, and similarly, a right lateral movement causes rotation about the right condyle. Between each lateral excursion, the condyles assume their most retruded position (Fig. 10).

This technique uses two pieces of apparatus,

Fig. 8 Conventional upper and lower rims

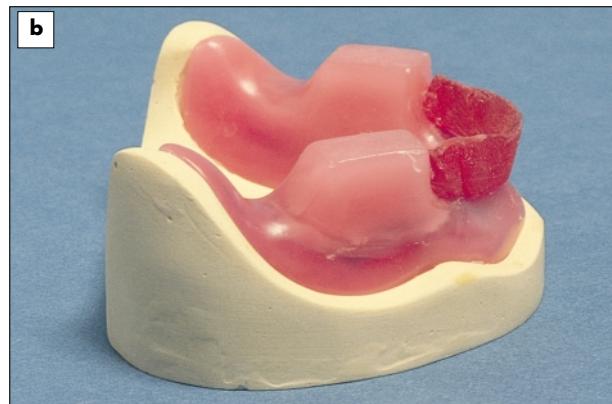
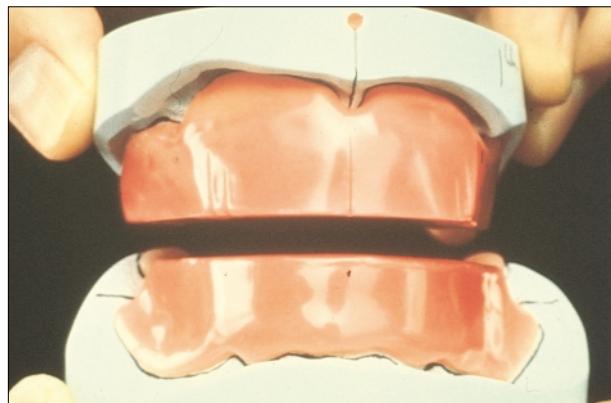


Fig. 9 a) 'Manchester' rims — to simplify complete denture registration technique; b) Addition of carding wax to the labial segment of the lower rim can help create a functional modelling of the denture space anteriorly

one for each arch, both mounted on rigid stable bases, usually made of light-cured polymethylmethacrylate (PMMA). The upper apparatus comprises a metallic plate that spans the maxillary arch. The lower has a bar containing an adjustable central-bearing screw (1mm thread) mounted on wax or compound 'pivots' added to a light-cured PMMA base (Fig. 11). The lower plate lies over the most stable pivotal areas of the arch. The adjustable central-bearing screw is made to contact the upper plate at right angles and at the selected OVD. The bases are adjusted so that no contact between them can occur and the patient can make lateral mandibular excursions with contact of the central-bearing pin on the upper plate only. The patient is requested to swallow, to indicate a 'central' (RCP) position, then asked to make three protrusive movements before returning to RCP. From RCP the patient is asked to make three left lateral excursions and then to return to RCP. Finally, the patient is asked to perform three right lateral excursions before returning to RCP. The patient should then be familiar with the two pieces of apparatus and the practitioner can then proceed to record the tracing. This is done by coating the upper plate with, eg ink from a felt tipped pen and then asking the patient to replicate the protrusive and lateral movements. The alternate lateral jaw movements scribe on the upper plate two arcs of rotation which intersect in a position corresponding to RCP. Clearly, it is from this point that an intersection (arrowhead) with the protrusive movement is also traced (Fig. 12a). To validate this position a perforated perspex cover slip is positioned with the perforation over the arrowhead and waxed in place. The patient is then asked to swallow and confirmation of RCP is achieved by the central bearing screw engaging the perforation (Fig. 12b).

This fixed registration records the vertical and antero-posterior intermaxillary relations. To record the coronal relationship, Plaster of Paris or PVS putty is then placed between the

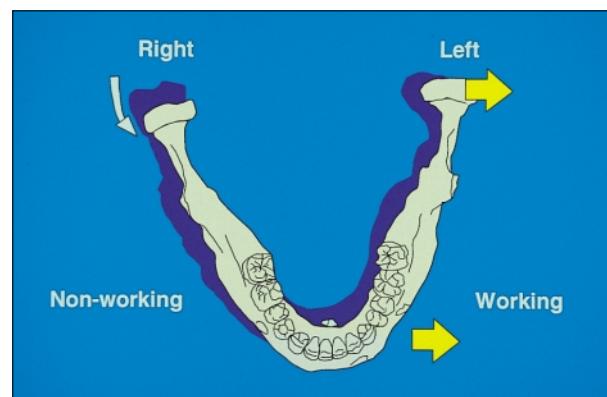


Fig. 10 Line drawing of occlusal view of mandible and arcs of movement about the condyles

bases and the central-bearing screws to ensure an unambiguous relationship (Fig. 12c).

Extra-oral tracing

The extra-oral tracing is somewhat similar to that of the intra-oral, except that the tracing apparatus is attached to plates that protrude between the lips. It is not considered to be as accurate as that of the intra-oral method for edentulous patients because the protrusion of the recording apparatus is so far forward of the pivotal area that tilting and/or deflection of the bases is likely.⁴ In addition, as this technique is not universally taught worldwide, it will not be described further.

Further considerations

When these three-dimensional intermaxillary registrations have been completed, they will be sent to the laboratory along with the ACB and facebow transfer to be articulated. While teeth have still to be selected (see Part 7) it is appropriate to consider briefly, the types of articulator on which the casts are to be mounted, as the proper adjustment of these may require additional records.

Articulators for complete dentures

The usage of articulators to enhance clinical practice has been the subject of a recent review⁵ and thus we shall confine our discussion to simple basic points.

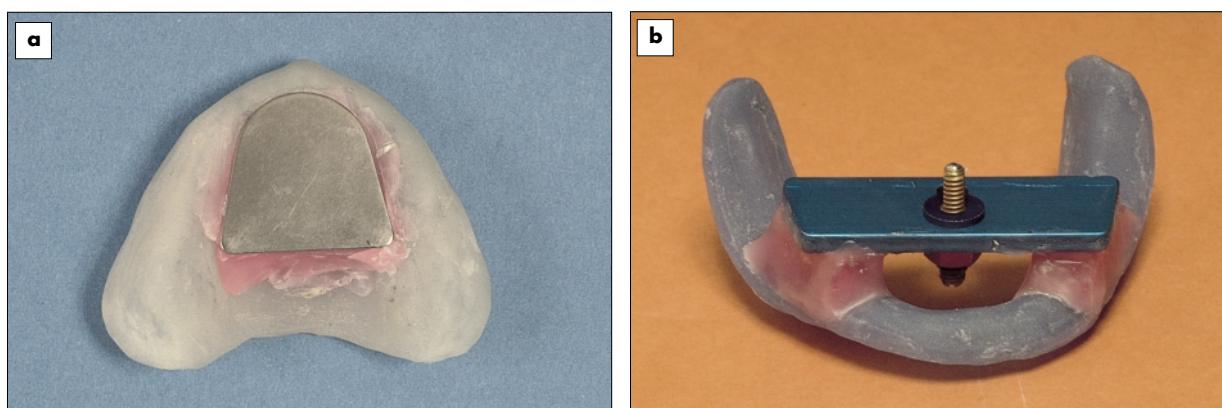


Fig. 11 Apparatus for measuring Gothic arch tracing. **a)** Upper base plate; **b)** Lower base, bar and central-bearing screw

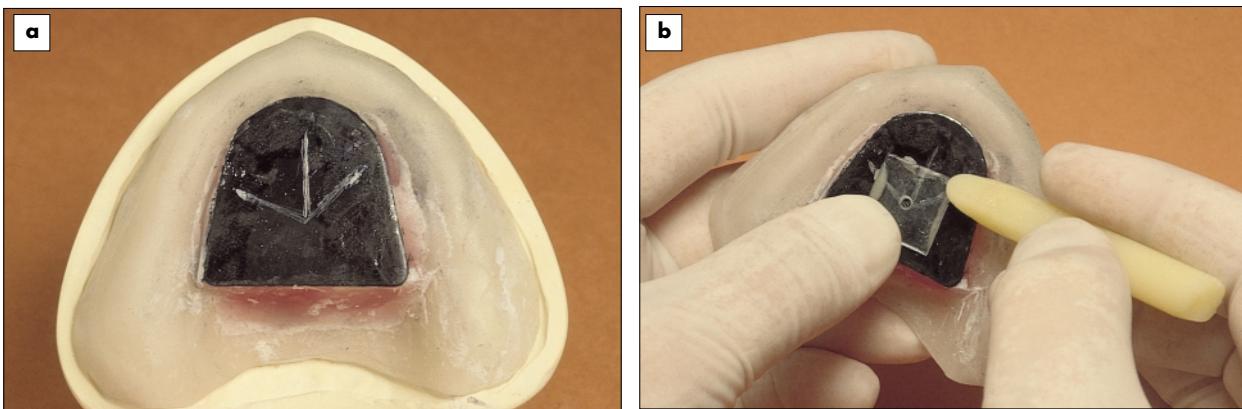


Fig. 12 a) Typical Gothic arch or arrowhead tracing of the mandibular movements
b) Perspex locator placed over the arrowhead point to confirm reproducibility of RCP
c) PVS putty moulded between the upper and lower bases to provide a coronal relationship

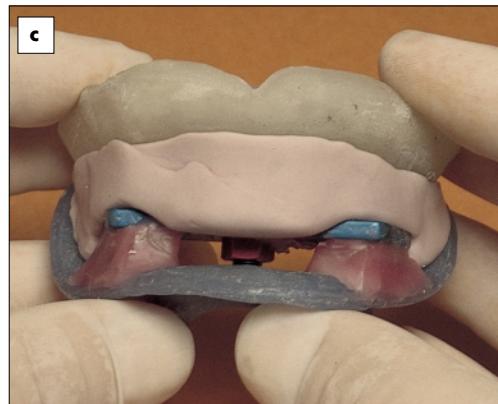
Articulators in common use for the production of complete dentures comprise (Fig. 13):

- Simple hinge (plane line)
- Moveable, fixed condylar path
- Semi-adjustable.

The simple hinge articulator allows the construction only of a centric occlusion, whereas the fixed condylar path instrument allows some approximate lateral and protrusive occlusion to be developed. The semi-adjustable articulator allows the establishment of more accurate or customised lateral and protrusive as well as centric occlusion.

Few simple hinge articulators have provision for accepting a facebow record so that this further limits their usefulness. Both the fixed condylar and the semi-adjustable types will accept facebow records, and, in addition, the more adjustable instruments accept protrusive and lateral interocclusal records to allow full benefit of their capability. Facebows improve the accuracy of occlusal development of these articulators. Facebows were discussed in Part 6.

With the maxillary cast mounted via a



facebow transfer and the mandibular arch related to the maxillary arch via the gothic arch tracing, the development of satisfactory eccentric (lateral and protrusive) occlusion and articulation is possible. In addition, small changes (2–3 mm) in the vertical dimension may be achieved on the articulator, should this be required, without the need for a new registration.

Helpful Hints

- 1 Determine what freeway space is appropriate for each patient.
- 2 Confirm RCP is reproducible.
- 3 Ensure the completed intermaxillary records are sealed together and are unambiguous.

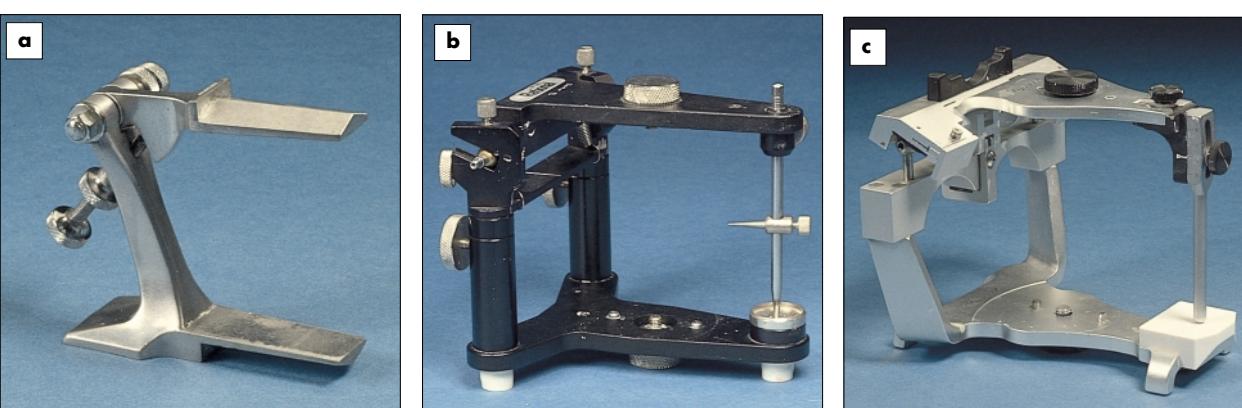


Fig. 13 a) Simple hinge articulator. b) Moveable fixed condylar paths articulator. c) Semi-adjustable articulator

7

Registration: Stage III — selection of teeth

J. F. McCord,¹ and A. A. Grant,²

**In this section,
particular attention is
drawn to guidelines
on the selection of
teeth for complete
dentures. Factors
influencing selection of
teeth are discussed
and presented in
tabular form for easy
guidance.**

**In this part, we will
discuss:**

- How to select appropriate moulds of anterior teeth
- How to select appropriate moulds of posterior teeth
- Factors influencing shade of teeth

As has been mentioned in Part 1, in the United Kingdom the dental surgeon is the sole agent licensed to prescribe and co-ordinate the functional and aesthetic requirements for each patient's replacement teeth. In the decision-making required for the selection of replacement (denture) teeth for edentulous patients, the dental surgeon should show a knowledge of physiological and biological factors pertinent to each patient. These factors should be co-ordinated with aesthetic factors applicable to each patient, taking notice of patient perceptions of appearance.

Dental literature is replete with anecdotal references to aesthetic aspects of complete denture construction but this is an imprecise area, combining 'scientific' and 'artistic' principles. The 'scientific' principles are based on reasonably limited longitudinal studies that, ultimately, may not necessarily cater for the needs of each individual patient, while the 'artistic' component is a paradigm of clinician's skill, technician flair and patient acceptance. The integration of these principles has led to a variety of guidelines to help the dental surgeon in the selection of (replacement) denture teeth. Unfortunately, on the evidence of prescriptions sent to dental laboratories, it is clear that these well-intended guidelines are often cast aside.^{1,2} It would seem, in general terms, that many clinicians fail to record any selection of tooth mould and/or shade and thereby abdicate the responsibility of selection of the shades and moulds to the dental technician. Equally, most clinicians spend perhaps one or two minutes over the selection of shades for six anterior fixed restorations but a fraction of that time for complete denture teeth.

Such lack of any consideration of the body image of the edentulous individual mirrors the status of complete denture prosthodontics in dentistry; for the sake of the edentulous population, and our profession, this must not be allowed to continue.

The purpose of this section is to simplify the task of selection of teeth by dividing the process into four separate stages:

- Selection of upper anterior teeth
- Selection of lower anterior teeth
- Selection of posterior teeth types and moulds
- Selection of shade(s) of the anterior and posterior teeth.

Selection of upper anterior teeth

Using pre-extraction records

If patients have pre-extraction records (eg photographs or casts) then the surgeon's task is simplified, although the clinician should always temper photographic evidence to accommodate for biologically/chronologically-induced age-changes. For example, the amount of central incisor tooth showing with the upper lip at rest in a 25-year-old tends to be considerably greater than that of a person in late middle age or older. Equally, the clinician should take into account other dental-related changes such as physiological wear of teeth and facial changes evident from the photograph (Fig. 1). Photographic features and/or peculiarities of lower anterior teeth and posterior teeth may also be determined. For this a good, clear photograph is required.

The use of photographs is to be strongly recommended. Particularly useful are those of a



**Fig. 1 Two
photographs to show
subtle facial and
dental changes which
can occur from late
youth to middle age**

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patient that were taken when the subjects was dentate or wore dentures which were admired by the patient. The photographs should realistically show head-on facial views of the patient smiling; failure to do this may not reveal any sign of the anterior teeth. Such views should enable the clinician to see and to measure carefully the ratio of the patient's horizontal inter-canine distance, and relate that to the interpupillary distance in the photograph. In the clinic, the clinician may then measure the patient's interpupillary distance and it should be possible to establish the horizontal width of the upper six anterior teeth (Fig. 2).

Other guidelines to the selection of replacement upper anterior teeth are itemised in Table 1.

In most cases, however, no adequate photographs or other pre-extraction records are available and the clinician has to decide how best to select the teeth that will satisfy aesthetic and functional parameters. It is at this stage that guidelines relating to anterior tooth positioning may be used and these guidelines are centred on the fact that the (six) upper anterior teeth should:

- Appropriately support the upper lip
- Occupy that area of the upper anterior arch bordered by the corners of the mouth
- Allow for individualisation where indicated, eg rotation, imbrication or spacing.

It should be stressed that the patient may well

be entirely satisfied with the teeth on their present (or perhaps an earlier favoured) denture and there is much sense in repeating the prescription of existing moulds.

We would argue that to achieve this, the clinician should select the teeth on the basis of measurements and decisions made with the upper rim still in place, in order that functional and aesthetic parameters may be assessed (see Part 5).

With the upper rim in place and the lip appropriately supported (see Fig. 8, Part 5) and the incisal point determined, the patient should be asked to smile. By marking the outline of the high smile line on the upper rim, the clinician is assisting the decision making for tooth moulds (Fig. 3). Another critical point is to determine the position of the canine teeth. Earlier reference has been made to the use of pre-extraction records. Where these are not present, some authorities advocate using the position of the corners of the mouth, at rest. Another method, used by the authors, is to ask the patient to smile and to extend a line from

Fig. 2 (below) Template to assist in formulating the (horizontal) width of the upper six anterior teeth

Fig. 2	Formula for calculating horizontal width	
	$\frac{\text{Width of upper six anterior teeth (photograph)}}{\text{Interpupillary width (photograph)}} = \frac{\text{Width of upper six anterior teeth}}{\text{Interpupillary width (actual)}}$	

Table 1 Guidelines to the selection and position of upper anterior teeth* indicates that photographs of appropriate quality are used

Nature of guideline	Frontal view	Sagittal view	Coronal view	Other
Pre-extraction	Photograph *Relate canine points to pupils *Relate canine points to inter-alar width (smiling) *Relate six anterior teeth to smile line Cast of arch Radiograph Relative with similar facial appearance	Photograph Cast of arch *Relate six anterior teeth to smile line Cast of arch Radiograph Relative with similar appearance	Photograph (unlikely) Radiograph (unlikely) Relative with similar appearance	Extracted teeth
Post-extraction	Central incisors restore philtrum if possible Central incisors restore vermillion border Incisal points and smile line determine height of tooth (age-related) Position of canine points Relate to inter-alar width (smiling) Relate to pupils (require pre-extraction photograph) Relation of upper rim to smile line	Vertical naso-labial angle Amount of tooth showing below lip at rest (age-related)		

Fig. 3 The scribing of the high smile line on the ACB helps the clinician to determine the height of the central incisor tooth. Care should be taken to compensate for tooth wear



Fig. 4 Dental floss used to give an acceptable guideline for the position of the canine tip on the ACB

the inner canthus of the eye via the lateral border of the alar cartilage and extend that onto the upper rim. This may be done with a ruler or by the use of dental floss (Fig. 4). This equates, in a high proportion of cases, to the position of the tip of the upper canine teeth.³ If a flexible ruler was laid from one canine point to another on the upper rim (aesthetic control base [ACB]), the length of the 'aesthetic anterior arc' could be read off; this reading is the second critical dimension required to prescribe tooth moulds (Fig. 5). Prior to scrutinising mould charts, however, it is of critical importance that the clinician determines how the patient desires the tooth arrangement to look. If the patient wishes spacing, then clearly that would require teeth of a smaller width to be used. The converse is true where imbrication or crowding is desired. The importance of the two measurements is apparent when one examines most tooth mould charts. Figure 6 illustrates typical measurements associated with all anterior teeth, although in the interests of fairness, fictitious mould names have been incorporated to avoid apparent favouring of any one mould. It can be seen that there are three values allocated per mould:

1. The combined widths of all six anterior teeth, ie from distal of canine to distal of the

contralateral canine (in mm). NB This is approximately the circumference of the upper rim from one canine point to the other plus 8–10 mm.

2. The height of the central incisors from the incisal edge to the highest point on the labial face of the tooth corresponding to the highest point of the crown (in mm).
3. The width of the central incisors.

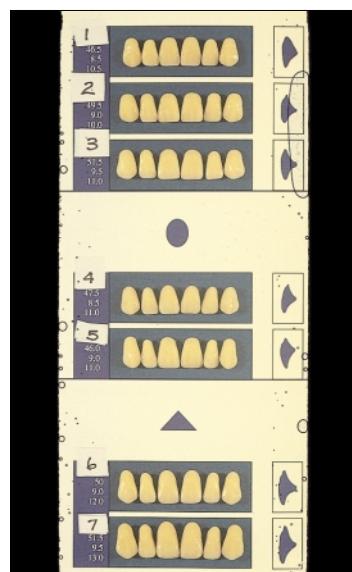
While the third value is of use in the prescription of removable partial dentures, we do not see any obvious value in the determination of tooth moulds for replacement complete dentures other than ensuring that replicated moulds are copied faithfully.

Armed with these two measurements, which may be read off the record rim, the clinician should be able to select from those moulds that lie within 1 mm of the selected intercanine distance. Similarly, an awareness of dental ageing changes is required when the height of the central incisors is being considered. The distance measured from the record rim is from the incisal tip to the high smile line. Most prosthodontic textbooks recommend that the highest point on the labial aspect of the crown lies 1 mm above this; clearly for middle-aged and older patients, modification of the central incisors will be required (ie remove the translucent tip of the incisal edge) to reflect the age of the patient (Fig. 7). In order to customise the anterior teeth to reflect the age of the patient, the clinician will usually select longer central incisors than would be expected, to permit incisal grinding. On the other hand, some patients may not show much of their teeth when they smile. This may be a cultivated habit, for socio-psychological reasons, a consequence of tooth wear and a long upper lip, or perhaps simply a feature peculiar to these patients. This may be clear from a good photograph of the patient smiling. It may also be

Fig. 5 Flexible ruler used to measure the (labial) circumference of the arc from one canine tip to the other. As tooth mould charts for anterior teeth give dimensions from the distal of one canine to the other, 8–10 mm should be added to the above measurement, to cater for the distal 'half' of each canine



Fig. 6 Tooth mould chart indicating dimensions of several moulds



apparent at the time of preparation of the upper rim (ACB).

The clinician is, at all times, advised to consult with the patient regarding the patient's wishes and expectations on tooth selection, to avoid, or at worst to minimise, any potential problems of acceptance of the replacement denture at a later date.

Clinical experience, however, indicates that even when these two measurements are followed, other factors are brought into play to finalise anterior tooth selection. Williams, in 1907, suggested that the frontal appearance of the face from the (normal) hairline to the chin could be used as a guideline to the inverse shape of the central incisor (Fig. 8).⁴ Some tooth manufacturers, in an attempt to assist clinicians to select appropriate tooth moulds, suggest that the labial shape of the anterior tooth reflects the shape of the (edentulous) maxillary arch. Neither of these has any scientific credence, indeed the latter takes no account of trauma or unusual post-extraction changes.

We recommend that clinicians should assess the facial profile in a three-dimensional way. This involves incorporating frontal and lateral views plus that taken from behind the patient looking down the face, to determine an overall view of the dento-facial profile. Patients from each of the skeletal classifications may be identified and this can help the clinician select a tooth mould which is in accordance with the profile of the appropriately supported lip (Fig. 9) on the basis of clinical experience of facial forms.

Selection of lower anterior teeth

As has already been referred to, pre-extraction records may be used to ensure appropriate tooth selection and, indeed, the anterior form of the trial dentures.

When these are not available, referral may be made to manufacturers' mould charts to equate the lower anterior teeth to the selected upper anterior teeth. Or the practitioner may opt to create a functionally-generated profile of the lower denture space⁵ (sometimes called the neutral-zone impression technique), identify the position of the lower canines (via the angle of the mouth) and then measure the canine-canine distance. As tooth moulds for lower anterior teeth have the equivalent three measurements to upper anterior teeth, the clinician may choose for the mould that is appropriate for each patient, taking age, facial form and patient perceptions into account.

Selection of posterior teeth types and moulds

It is probably accurate to state that this portion of the prescription form is least considered by clinicians, the choice of posteriors being often



Fig. 7 Photograph of unprepared upper right central incisor from a mould (A). The modified tooth (B) has been adjusted to suit the patient by grinding away the incisal translucency. The clinician should compensate for this in selecting the mould

made by technicians who tend not to have seen the patient. This is a remarkable state of affairs when one considers that complete dentures are supposedly prescribed primarily to restore function and secondarily to restore facial appearance.

As this series is intended for interested general dental practitioners and not for specialists, there will be no section on the geometry of occlusion, as that will be covered in standard prosthodontic textbooks. It is pertinent, however, to discuss, albeit briefly, types of posterior teeth.

According to Lang posterior tooth moulds are of four types:⁶

1. Anatomic
2. Non-anatomic
3. Zero-degree teeth
4. Cuspless teeth.

According to the Glossary of Prosthodontic Terms, the following definitions apply to each type:⁷

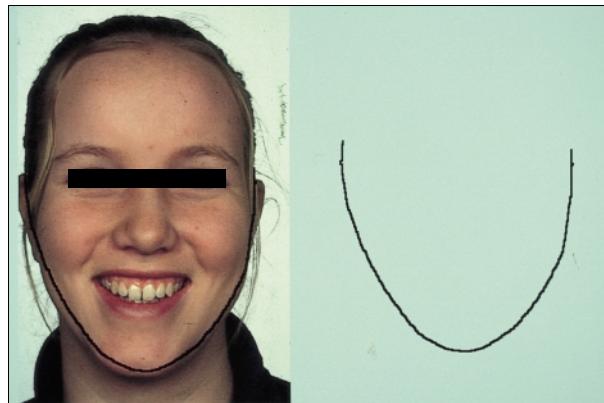


Fig. 8 Williams' guideline to tooth selection by relating upper central incisor form to frontal appearance of the face has no scientific credence



Fig. 9 With a well-formed upper rim (ACB) *in situ*, the clinician can interpret a skeletal form which may suggest an appropriate incisor arrangement. In this case, with the ACB, the v-shaped form of the maxilla is clear to see, suggestion of a Class II division I appearance

1. Anatomic: teeth that have cuspal inclinations greater than 0° and tend to replicate occlusal anatomy. Such teeth may have cuspal angles set to 20°, 30°, 33° or 45°.

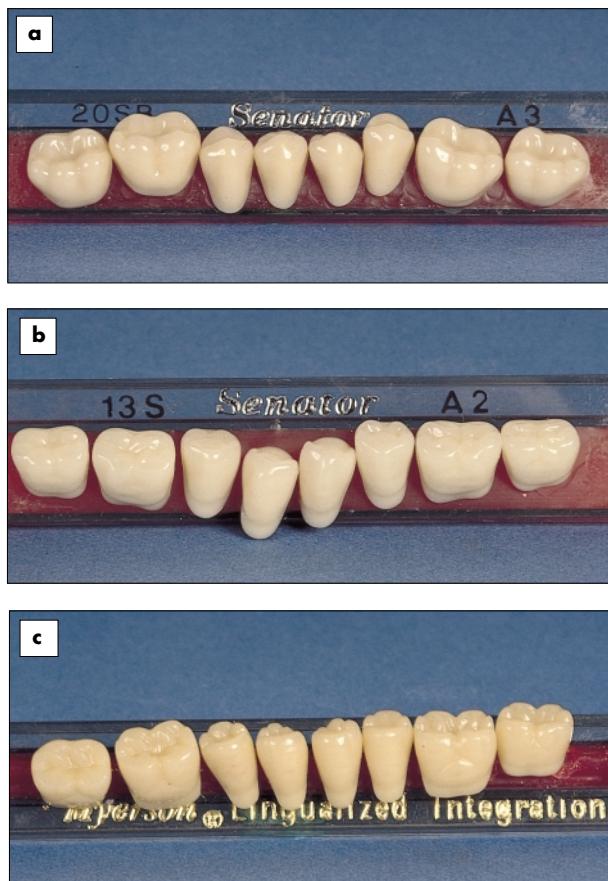


Fig. 10 a) Posterior teeth which have cusps b) Posterior teeth which are cuspless c) Hybrid mould ie teeth which are modified to obtain the benefits of a) and b)

2. Non-anatomic: teeth designed in accordance with mechanical principles rather than from the anatomic standpoint.
3. Zero-degree teeth: posterior teeth that have 0° cuspal angles.
4. Cuspless teeth: teeth designed without cuspal prominence on the occlusal surface ie inverted cusp teeth.

We would suggest, in the interests of clarity, that three types of posterior tooth form be considered, namely teeth with cusps, teeth without cusps and teeth which exhibit both characteristics (hybrid moulds). Such teeth typically have upper teeth with cuspal angles of 20° with modified buccal cusps and lower non-anatomic teeth which have been rendered essentially cuspless (Fig. 10a–c).

The decision the clinician has to make should be determined out of the needs of the patient. In essence, three factors have to be considered, namely occlusal factors, stability factors and aesthetic factors (Table 2).

Occlusal factors

If the patient only performs vertical mandibular movements then it is possible that cuspless teeth will suffice. If, however, the patient performs ruminatory mandibular movements (watch the patient eat a biscuit or a piece of carrot), then teeth with cusps will be required for balanced articulation (and thus stable dentures). Examination of current dentures may assist in the diagnosis (Fig. 11). For example, if

Table 2 List of factors influencing selection of posterior tooth form

Type of Tooth	Occlusal factors	Stability factors	Aesthetic factors
Teeth with cusps	<p><i>Balanced occlusion</i> Possible, but may require grinding to prevent slide from RCP to ICP</p> <p><i>Balanced articulation</i> Cusps are required to obtain a truly balanced occlusion, but technician's skills and time are implicit, as is sound registration technique</p>	If no slide present, stability possible Can be problematic with flat lower ridges and in implant-borne cases	Tend to look better as they appear natural, as long as teeth of appropriate length are selected
Teeth without cusps	<p><i>Balanced occlusion</i> Possible and these teeth generally take less laboratory time to set up</p> <p><i>Balanced articulation</i> A truly balanced articulation is not possible with these teeth</p>	Absence of cusps in the upper posterior teeth means balanced articulation is not possible	Have a worn (attrited) appearance
Hybrid teeth	<p><i>Balanced occlusion</i> Possible some grinding may be necessary</p> <p><i>Balanced articulation</i> Possible if concepts such as lingualised occlusion are used, ie the maxillary palatal cusps are intended to maintain contact with their antagonists</p>	The presence of cusps, even modified cusps, can facilitate balanced articulation with reduced chance of cuspal locking	Can look natural

the dentures have occlusal surfaces that are evenly worn (ie flat), this is usually suggestive of vertical (chopping) mandibular movements, whereas much greater wear of the maxillary buccal cusps especially, is suggestive of ruminatory mandibular movements.

Stability factors

In addition to stability engendered out of muscle balance and occlusal balance in all border positions, cusps that tend to lock or cause tripping can aggravate the stability of dentures. This is particularly pronounced in flat, atrophic mandibular ridges. Some schools of thought automatically prescribe cuspless teeth in such cases; clearly if balanced articulation is required, cuspless teeth are, in such cases, illogical. Another factor to consider is the width of the posterior teeth. If the posterior teeth are too broad, they could present to the tongue what amounts to lingual undercuts and the presence of these could lead to a major cause of instability (Fig. 12).

Thought should also be given to the number of posterior teeth. There are few clinical situations where there is sufficient mesio-distal length to incorporate two molars and two premolars without compromising stability (see Part 10 on diagnosis of faults); common options are to drop off either one premolar or one molar.

Aesthetic factors

These factors are ones that can only be determined by the patient and are a good example of the value of informed consent; the patient should be informed of the options and allowed to decide on the appearance of posterior teeth as well as anterior teeth.

Selection of colour and shade of teeth

As this book is intended to serve as a clinical aid for general dental practitioners, no attempt will be made to detail the fundamentals of the colour scheme.

While great care is often spent by dental practitioners over the selection of teeth of appropriate colours and shades, eg six anterior crowns, conventional wisdom would suggest that this is not the case where the selection of teeth for complete dentures is concerned.

Nevertheless, practitioners should take into account four qualities when selecting denture teeth.

1. *Hue:* This is a specific colour resulting from light of a particular wavelength acting on the retina. The hue is an indication of a specific colour, eg blue, green, reddish yellow. Some authorities suggest that the hue of teeth should harmonise with the hue of the patient's face/natural hair. Others, however, quote studies that cast doubt on this philosophy.⁸
2. *Saturation (chroma):* This represents the amount of colour per unit area, eg a tooth may appear greyer than another tooth. The hue of both teeth could be equal or one tooth could contain a higher saturation of the grey than the other.
3. *Brilliance (value):* This equates to the lightness or darkness of a tooth. Variations in brilliance are affected by dilution of the colour (ie the hue) by black or white. It is the ratio of white or black on teeth to the natural hue which determines the lightness or darkness of teeth.
4. *Translucency:* This property enables light to pass through a body without giving any distinguishing image.

The careful selection of colours and shades of teeth is therefore verging on the artistic interpretation of the clinician and the patient. The patient may have very strong views on the shade of their replacement dentures and it may be a clinical advantage to have two options available in shade guides. One is the standard shade guide which is calibrated in shades A, B, C and D. The second option is ranged from the lightest



Fig. 11 This patient clearly undertakes a range of border movements and should be provided with balanced articulation



Fig. 12 The occlusal tables on this lower denture are too large. First of all, the excessive width of the molars is presenting lingual undercuts which will de-stabilise the denture. In addition, the presence of the second molar on the inclined plane of the ramus will induce a protrusive movement

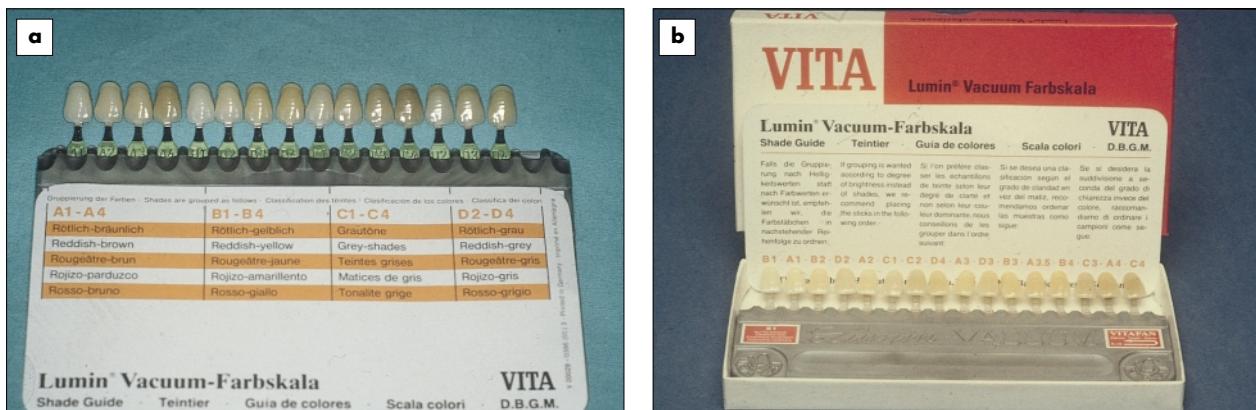


Fig. 13 Vita shade guide: a) arranged according to colour; b) according to lightness

- 1 Basker R M, Ogden A R, Ralph J P. Complete denture prescription — an audit of performance. *Br Dent J* 1993; 174: 278-284.
- 2 Barsby M J, Hellyer R P, Schwarz W D. The qualitative assessment of complete dentures produced by commercial dental laboratories. *Br Dent J* 1995; 179: 51-57.
- 3 Grant A A, Johnson W. *Introduction to Removable Denture Prosthodontics* 2nd ed. pp 88-89. London: Churchill Livingstone, 1992.
- 4 Williams J L. A new classification of human tooth forms with special reference to a new system of artificial teeth. *Dent Cosmos* 1914; 56: 627-628.
- 5 McCord J F, Grant A A, Quayle A A. Treatment options for the edentulous mandible. *Eur J Prosthodontics Rest Dent* 1992; 1: 19-23.
- 6 Lang B R. Complete Denture Occlusion. *Dent Clin N Amer* 1996; 40: 85-101.
- 7 American Academy of Prosthodontics. Glossary of Prosthodontic Terms. *J Prosthet Dent* 1994; 71: 56-107.
- 8 Landa L S. Anterior tooth selection and guidelines for complete denture aesthetics. In Winkler S (ed). *Essentials of Complete Denture Prosthodontics* 2nd ed. St. Louis: Mosby 1988, 202-216.

shade C to the darkest shade (Fig. 13a and b). We would emphasise a careful and deliberate consultation with patients regarding shades of teeth, taking into account age (teeth tend to become darker with age although this is not always absolute), patient preference and, with guarded reservation, skin colour. The selection may also be varied, eg there is often justification in having canine teeth slightly darker than incisors (Fig. 14).

When all of these details have been recorded on the laboratory (prescription) card, the rims may be dispatched to the laboratory for final dentures to be made.

Helpful Hints

- 1 Listen to the patient's views.
- 2 Use photographs/favoured dentures if possible.
- 3 Use the aesthetic central base to assist in the delineation of the maxillary 'anterior aesthetic arc'.
- 4 Select lower anterior teeth to complement the upper anteriors.
- 5 Select posterior teeth using aesthetic and functional criteria.



Fig. 14 View of natural incisors. Note there is no real harmony between the hue of the face and that of the teeth. The canines, however, are darker than the incisors

8

Trial dentures, insertion of processed dentures and review of complete dentures

J. F. McCord,¹ and A. A. Grant,²

In this section, checklists are described to assist the practitioner in verifying the acceptability/non-acceptability of complete dentures at trial insertion and insertion visits. The relative roles of clinician, technician and patient are discussed.

In this part, we will discuss:

- The integral aspects of the trial denture visit
- The integral aspects of the insertion visit
- What to do at the review appointments

This chapter will be divided into three sections: one devoted to clinical aspects of the delivery of trial dentures, another to the delivery of the processed dentures, and the third section will deal with the review appointment.

Trial insertion of complete dentures

By definition, a trial denture is the arrangement of teeth in wax, for trial, prior to completion of the denture.¹

By convention, this stage typically occupies one clinical visit, unless the trial denture has errors which are of clinical and/or technical origin! The temporal constraints of prosthodontic practice under NHS Regulations have often perceived this visit to be transient by nature. We would seek to redress this scenario and offer the suggestion that two trial visits may be considered as being both sensible and practical.

In the same way that the trial visit is often labelled a dress rehearsal, the analogy to our thespian counterparts is worth closer investigation. The role of a dress rehearsal for a theatre company is threefold. First of all, it enables actors to verify that they are all word-perfect. Secondly, it enables the wardrobe manager to confirm that the costumes and props are appropriate, both from a point of fit and also for verifying the temporal continuity of the costumes to the historical period reflected in the play. Finally, it enables the director to establish that all lighting changes and stage scenery are acceptable.

It is therefore perhaps appropriate to specify the role of the trial denture stage(s). Again, three aspects must be considered.

- The functional and aesthetic acceptability of the dentures, according to the dentist (dentist's role).
- The functional and aesthetic acceptability of the dentures, according to the patient (patient's role).
- The competence of the technical delivery (technician's role).

These components are summarised in Table 1.

The dentist's role

On receipt of the articulated trial dentures, the clinician should perform more than a cursory examination of them prior to their placement in the mouth. The first stage is to ensure that the maxillary and mandibular trial dentures are well adapted to the respective master casts and that both bases are stable. The technician is responsible for ensuring the accuracy of fit of bases to casts while the ultimate responsibility for the accuracy of reproduction of the oral tissues rests with the clinician who recorded the definitive impression.

The next stage is to remove the mandibular trial denture from the articulator and to assess the relationship of the maxillary posterior teeth to the mandibular ridge. As a general guide to (lower) complete denture stability, the palatal cusps of the maxillary premolar and molar

Fig. 1 Relationship of maxillary palatal cusps to the mandibular ridge. It is recommended that these cusps are placed over the lower ridge crest and thus occlude with the central fossae of the mandibular posterior teeth



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Table 1 Summary of components for trial denture assessment

Personal responsibilities	Factors to be considered
Dentist's role	<ul style="list-style-type: none"> • Ensure that the trial dentures fit the master casts and that the bases are stable. • Verify the vertical, sagittal and coronal intermaxillary relations. • Verify the stability of the bases in the mouth. • Verify the selection of anterior and posterior teeth, their colour and that the occlusal planes are correct. • Verify that speech is lucid. • Verify that the waxwork is aesthetic and functional.
Patient's role	<ul style="list-style-type: none"> • To record their wishes and expectations. • Informed consent agreed and that the patient approves of any alteration in form from the previous dentures. • The patient, and any accompanying person, should agree on the acceptability of the trial dentures and that the patient is happy to proceed to completion.
Technician's role	<ul style="list-style-type: none"> • To have replicated the registration records faithfully. • To place teeth according to prosthodontic norms. • To provide stable bases. • To ensure that balanced occlusion/articulation is provided, according to the prescription by the clinician. • To have articulated casts appropriately and to have set condylar angles to any prescription given. • To ensure waxwork is complementary to the age and personality of the patient.

teeth should lie over the mandibular ridge (Fig. 1).

With the mandibular denture still off the articulated mandibular casts, there is much merit in assessing the position of the posterior teeth by holding a straight-edged instrument on the ridge-section of the mandibular denture (Fig. 2); the central fossae of the lower posterior teeth should overlie the straight edge (this represents the zone occupied by the palatal cusps of the maxillary posterior teeth in retruded contact position [RCP]).

When both trial dentures have been removed from the articulator, the clinician should inspect the intermaxillary space to ensure no unplanned increase or decrease in dimension has occurred. If an intra-oral tracing method was used, the intermaxillary space may be verified by examining the central-bearing apparatus that should still be in the work tray. This provides a good guide to the distances between the upper and lower ridges. The clinician should also examine the casts to ensure that no laboratory-induced defects have been induced on the denture-bearing areas.

If both dentures are replaced on their respective casts, the clinician may then examine the occlusal relationships of both dentures, to establish that balanced occlusion is present and, if requested, that balanced articulation has been realised.

With the patient present, and following infection control procedures,² the mandibular denture may be inserted in the patient's mouth. There are several reasons why there is merit in inserting the mandibular denture first.



Fig. 2 A wax knife is placed over the 'ridge space' of a trial denture to help relate the accurate placement of the mandibular posterior teeth

- If the maxillary denture is inserted first, the two buccinator muscles are, ideally, restored to their functional width and subsequent insertion of the mandibular denture may stretch the oral commissures; this may be a source of discomfort for many long-term edentulous patients.
- If the maxillary denture is inserted first, insertion of the mandibular trial denture may dislodge the upper denture and this may alarm the patient unnecessarily.
- The verification of a stable denture base and, further, of a peripheral seal in a lower denture is a source of relief and a confidence builder for patients who have a history of lower denture problems.
- The patient may be shown how to use the tongue to control or 'weigh down' the mandibular denture. Careful instruction, at this stage may assist the patient to establish good circum-denture muscle balance which will enhance denture stability (Fig. 3).

When the mandibular denture has been inserted, it should be checked for stability. If the

base is stable on the master cast and unstable in the mouth, the possibility of a faulty definitive impression must be considered; if this is the case, a new definitive impression is indicated.

The extension of the mandibular denture base should also be assessed, bucco-labially and lingually. Over-extension should be removed and under-extension corrected; if the latter is a consequence of lack of extension into the master cast, the deficiency may be resolved by addition. If, however, the master cast is under-extended, problems of support and stability may arise (see Part 10), and a new definitive impression is indicated — the importance of educating the patient on how to control the lower denture has already been referred to. These factors should, of course, have been identified and corrected at the registration stage, but the thoroughness of double-checking at this stage should reduce post-insertion problems.



Fig. 3 The lower trial denture is controlled by the circum-denture musculature to enhance stability and improve patient confidence

The maxillary trial denture is then assessed for stability and for over-/under-extension. The same guidelines for under-/over-extension of the lower denture base apply for the upper denture.

When both trial dentures are in the mouth, the following four aspects of the dentures may be assessed in turn.

- Occlusal relations.
- Occlusal planes.
- Appearance of teeth and gums (gingival matrix).
- Speech — should not be adversely affected by dentures.

Occlusal relations

As has been pointed out in Part 6, there are three intermaxillary relations to consider. These are the vertical, antero-posterior or sagittal and coronal intermaxillary relations.

The vertical relation is the occlusal vertical dimension (OVD) and the clinician should ensure that this has been reproduced faithfully from the registration sent to the technician. Figure 1, Part 6 illustrates how resting vertical dimension (RVD) and OVD may be measured to determine if the FWS is appropriate and the

significance of this cannot be understated. As will be detailed later, vertical relations may also be assessed phonetically.

The sagittal or antero-posterior relation, at the established OVD should, in the complete denture patient, incorporate the retruded contact position (RCP) which is coincident with intercuspal position (ICP).³

The coronal relation relates the mandibular arch to the maxillary arch in a relationship generally observed from the frontal aspect.

The minimal requirement of all complete dentures is that all posterior teeth of both dentures (including canines) meet simultaneously and evenly in RCP. If balanced articulation is required, this should also be present in right and left working and protrusive movements. Verification of balanced articulation at the trial denture stage is recommended but should be done cautiously as the teeth are set in wax and may be dislodged if the patient is over-vigorous — even in the absence of occlusal interferences.

If the occlusal relation on the articulator is not matched in the mouth, especially RCP, the clinician should consider re-registering the occlusion. Only if there is a slight slide from RCP to ICP (ie less than 0.5 mm) can the clinician justify not re-registering the intermaxillary relationships.

If the occlusal relations are acceptable, the clinician should then confirm the acceptability of the occlusal planes.

Occlusal planes

In this category, four planes may be considered, namely the incisal plane, left and right posterior occlusal planes and the plane of the mandibular teeth.

Incisal plane: The inter-pupillary line is an acceptable guideline for this plane and the clinician, and the patient, should confirm its acceptability.

Right and left occlusal planes: Standard guidelines for these planes are that they should be parallel to the alar-tragus line and instruments such as Fox's occlusal plane guide may be used to confirm these planes (the right may not equal the left). Inappropriately formed planes may result in occlusal errors that may result in pathognomonic signs and symptoms (see Part 10).

Plane of the mandibular teeth: Ideally, the resting tongue should overlie the lingual aspects of the lower teeth and this may be demonstrated to good effect at the trial denture stage to augment (lower) denture stability *vide supra*.

Appearance of teeth and gums (gingival matrix)

This aspect of the trial denture visit(s) is of considerable importance to the patient and the acceptance of the dentures by the patient

reflects the acceptability of tooth positioning, tooth selection and colour selection by the clinician plus the technical competence of the technician. Given the complexity of occlusal and aesthetic factors, we recommend that two trial visits, as a minimum, be allocated. This is especially valid when patients have a history of denture-related problems or where difficulties are anticipated.

It is easy to be confused, if not discouraged, when there is a need to adjust twelve or fourteen teeth per denture. There is, therefore, merit in asking the technician to set-up only the six anterior teeth in each denture for an initial trial insertion. The appearance of only six teeth per denture may be seen, altered and agreed upon easily. In addition the vertical and antero-posterior intermaxillary relations of the trial dentures can be verified (Fig. 4).

When the form and arrangement of the upper and lower anterior teeth have been agreed upon, the second trial denture visit could be arranged, at which the posterior teeth are positioned and occlusal relations could be checked.

It must not be overlooked, however, that the technician's skills lie not only with tooth placement and angulation; in addition to these factors related to appearance is the contour of the waxwork equivalent to the gingival architecture. Here, the interdental papillae should be convex, the papillary lengths varied and the tissue heights formed appropriately to create a natural appearance (Fig. 4).

Speech

Speech is an important function that in general often receives scant attention from the dental profession. Most dentists are aware of the importance of clarity of sibilant sounds, in particular the test for the 'closest' speaking space, ie ask the patient to say 'Mississippi'.

Other phonetic tests which may be used relate to other consonant sounds, namely fricatives or labio-dental sounds (eg 'f' or 'v'). By asking a patient to say a sentence such as 'fish and vinegar' the clinician can determine if the fricative sounds are clear and this will help verify the appropriate placement of the upper central incisors antero-posteriorly.

When all of these tests have been performed by the clinician, we would recommend that the clinician leave the patient for a short time with their trial dentures, preferably in the company of a friend. Then allow the patient to converse and, in general, acclimatise to the proposed form of the replacement denture. Thereafter any additional modifications may be made to the dentures.

When the patient and the clinician are both satisfied with the trial dentures, the dentures may be sent for processing. Prior to returning the trial dentures to the laboratory for process-

ing, thought should also be given to determining the shade of the denture base. This may be translucent in the palate, pink or veined or may be modified to conform to the gingivae of the patient.

The patient's role

The successful provision of replacement dentures owes much to patient co-operation and adaptation. Neither of these factors can be defined with clarity nor can they be easily quantified. For this reason, patient consent to form



Fig. 4 Six upper and lower teeth have been set up for the first trial visit. This allows the clinician to determine that the occlusal parameters are acceptable and that the patient and the clinician may judge the appearance of the anterior set-up

and appearance is paramount. As has been mentioned previously, we recommend that two trial denture visits be arranged, partly to facilitate any alterations to be performed at chairside by the clinician but also, of equal importance, to enable the patient to adjust and to consent to the form and appearance of the replacement dentures.

The technician's role

Although Part 9 will address technical considerations in the prescription of complete dentures, it is important to stress the importance of close, unambiguous communications between clinicians and technicians. The aims and objectives of a quality complete denture service should be common to both parties if the patient is to have any chance of adapting to replacement dentures. For these reasons, casts of acceptable quality require that impressions of acceptable quality are delivered. Similarly, technicians who spend a considerable time placing teeth in wax rims and then contouring the wax are understandably aggrieved when a reset is demanded because 'the bite is wrong'. The role of the technician is clearly that of a skilled team member who is wholly reliant on the clinician performing maximally.

Insertion of processed dentures

In essence, the clinical procedures of this stage mirror those of the trial denture stage, the exception being, hopefully, that the patient takes the replacement dentures home. Some technicians process dentures on the master

casts and return the polished, processed dentures to the clinician in a plastic bag or some other receptacle. Many quality laboratories, however, practice a more ideal technique of having the dentures processed on duplicated master casts, so that the dentures are returned on casts and on the articulator.

The advantage of some articulator systems, of which the Denar™ system is a good example, is that the laboratory work may be sent on the mounting platforms and the technician and the dentist may retain their own articulators, yet both may be confident of the accuracy of the mounting.

The benefits of each surgery having a good articulator cannot be over-emphasised, as it enables the clinician to thoroughly examine the trial dentures and processed dentures comprehensively before they are inserted into the patient's mouth. Assuming that the above practices are followed, the suggested sequence of events required at the delivery stage are as follows:

1. With the processed dentures on the articulated casts, verify that the dentures are in balanced occlusion, and that the incisal guidance post is in contact with the incisal guidance platform. If the post is off the platform, an occlusal error/disturbance has occurred and this should be identified, using articulating paper, and the premature contacts should be ground to enable the post to contact the platform.
2. Check working, balancing and protrusive occlusions. Again the post should remain in contact with the platform during these movements. A different colour of articulating paper is recommended for each excursion. Prematurities should be removed only after they have been identified via the articulating paper. Polish the occlusal surfaces that have been ground.
3. Remove the dentures from the casts and ensure there are no sharp ridges or acrylic pearls on the 'impression' surface of the denture.
4. After appropriate infection control, place the lower denture in the mouth and assess that no over-extensions occur along the periphery of the denture. Gently press on the occlusal surfaces of the lower premolar teeth and ensure no support problems are evident at this stage.
5. Position the upper denture and ensure that no over-extensions are present along the periphery. Similarly, ensure no support problems exist at that stage by pressing gently on the occlusal surfaces of the premolar teeth.
6. Confirm the occlusal relationships are acceptable, as per stages 1 and 2.

7. Confirm appropriate freeway space exists.
8. The patient then be re-instructed how to use the tongue to control the lower denture.
9. We further recommend that, at this stage, the patient should be instructed to bite on the tip of a cotton wool roll (or a carrot) between the first premolar and canine teeth of the upper and lower dentures on a preferred biting side. Instruct the patient to keep a grasp of the roll (unless this is painful) and then pull the cotton wool roll away from the patient. Pain indicates either that a support problem exists or that the denture base is unstable. As the latter should have been excluded before, the support problem may be located via pressure-relief paste and the denture base relieved appropriately (see Part 10). An acceptable occlusal result is perceived to have been obtained if the cotton wool roll breaks. The object of this exercise is to instruct the patient how to bite (ie teach the patient to 'caninise' to incise).
10. Finally, let the patient inspect the dentures in a mirror and assess speech by asking the patient to repeat their address, etc.

Review procedures

The topic of dentist-organised reviews is prone to variation. It is our practice to arrange a review 4 days after insertion and a second review 1 week after that. Depending on factors as diverse as status of denture-bearing tissues, patient perceptions, etc, patients may request further 'views'. The procedures for dealing with denture problems will be dealt with in Part 10.

Epidemiological data would support the annual review of complete denture wearers to screen for any pathological changes in the oral tissues or associated denture-related problems.

Helpful Hints

1. Closely scrutinise the trial dentures on the articulated casts — do they equate to what you prescribed, and are the trial dentures well adapted to the casts?
2. Confirm that the position of the anterior and posterior teeth is acceptable.
3. Place the lower denture in the mouth before the upper when assessing both dentures as a dental unit.
4. The planned usage of two trial visits has much merit. The first concentrates on verifying OVD, RCP and appearance. The second confirms posterior planes, mandibular movements and a refinement of appearance.

1 Nairn R I, Shapiro M M J. Prosthetic Dentistry Glossary in Guidelines *In Prosthetic and Implant Dentistry*, 1996. London: Quintessence Publishing Co, pp29-97.
2 *Control of Cross-Infection in Dentistry*. BDA Advisory Services.
3 Guidelines to Standards in Prosthetic Dentistry—Complete and Partial Dentures *In Ogden A (ed)* *Guidelines in Prosthetic and Implant Dentistry* 1996. London: Quintessence Publishing Co. Ltd, pp7-16.

9

Technical aspects of complete denture construction

J. F. McCord,¹ and A. A. Grant,²

This article deals with technical aspects of complete dentures as well as the importance of good communication between the clinician and the technician. The objectives for technicians for each component are discussed.

In this part, we will discuss:

- Technical objectives in the preparation of a cast for tray construction.
- Technical objectives of rim preparation.
- Aspects of tooth placement.
- The importance of good dentist-technician communication

On several occasions throughout this series, mention has been made of the need to establish, and maintain, a good working relationship between the clinician and the technician. In order that this relationship may be prosthodontically productive, respect has to be earned from both these members of the denture team. This requires that consistency of quality should be the aim for all stages of complete denture construction and by clinician and technician alike.

With the above in mind, this section seeks to highlight, on a chronologically sequential basis, the technical involvement with each clinical visit. To avoid repetition for each stage, it will be assumed standard practice for all work to be disinfected in the surgery and in the laboratory before commencement of each stage.

Primary impression visit

The primary aim of this visit is to record, in stock trays, the denture-bearing areas of each arch. According to the *Guides to Standards in Prosthetic Dentistry*,¹ there are basic requirements required for primary impressions, and these are listed in Table 1. In addition to these, it is recommended that the clinician, if not casting the impressions, will indicate the extent of the denture-bearing area. An indication, on the prescription form of the spacing for and design of the special tray(s) is also required, as the technician cannot tell from a stone cast the relative displaceability of tissues and, in consequence, where relief is required.

Technician's objectives

Figure 1 illustrates a good quality primary (plaster) cast that has faithfully reproduced all

of the requirements listed in Table 1. The identification of the outline of the peripheral extension of the special tray, scribed on the cast by the clinician, enables the technician to construct a special tray to the itemised instructions of the clinician. An example of a good quality light-cured special tray is shown in Figure 6, Part 4 — this tray had a 2 mm spacing overlying the cast.

Definitive impression visit

The aim of this visit is to record the denture-bearing tissues, at the appropriate degree of tissue displacement, in addition to recording the functional width and depth of the sulci. In this way, support, retention and some of the aspects of stability are addressed.

Technician's objectives

The definitive impressions are cast in stone or 75% stone-plaster mix (in the interests of strength) and these function as master casts. As was referred to in Part 4, the clinician should scribe, on the definitive impression, the position of the post-dam and also the planned preservation of the peripheral roll (*see Fig. 9, Part 4*).

By boxing out the land area relevant to the preserved peripheral roll, the technician should present a quality cast that only requires that the clinician inscribe the extent of the post dam.

Equally, it may be that some areas of the cast may require to have tin foil added to produce relief areas, or some areas, eg undercuts, may be blocked out using plaster (*Fig. 2*).

The responsibility for the selection of the material to form the base of the upper and lower rims rests with the clinician. Table 2,

Table 1 Minimal requirements of areas to be recorded in primary impressions for complete dentures

Maxillary arch	Mandibular arch
Residual ridge including the full extent of the tuberosities and hamular notch	Residual ridge, including the full extent of the retromolar pads
Functional depth of labial and buccal sulci, including fraenae and muscle attachments	Functional depth of labial and buccal sulci, including fraenae, muscle attachments and external oblique ridges
The hard palate and its junction with the soft palate	The lingual sulci, lingual fraenum, mylohyoid ridges and retro-mylohyoid areas

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Part 5 lists the materials which may be used as bases and most technicians should have the skills to make well-adapted bases (which will impart stability at the next clinical stage) in all of the above materials.

When the master cast has been completed to the needs of the patient, the technician has to produce record rims or upper rim/aesthetic control base (ACB) and central-bearing apparatus to the clinician's instructions.

Anecdotally speaking, this aspect of the clinician-technician interface is the weak link of the prescription process as the technician often has no way of knowing where to place the labial face of the upper rim, nor does he or she know the height of the labial face of the rim.



Fig. 1 Typical example of a good quality primary cast clearly demonstrating the primary and secondary support areas of the mandibular denture-bearing area. By definition, it is over-extended in order that the extent of the special tray may be traced appropriately (indicated)

It is entirely probable that a combination of diverse teaching philosophies concerning the placement of maxillary teeth on replacement dentures (and thus the form of the upper rim) among both clinical and technological teaching institutions has contributed to confusion on how technicians should make the upper rim/ACB. Copy denture techniques, the Alma gauge or the use of devices such as the alameter and the papillameter (Part 5) have assisted in helping the technician to customise an upper rim/ACB that should not require too much addition/removal of wax.

While the same thoughts apply for the lower conventional record rim, the simplification of the 'Manchester rim' or the construction of the central-bearing apparatus reduces the potential for confusion over dimensional parameters.

It is the objective of the technician to fabricate all of the component pieces for the third

clinical visit and to ensure that they are well-adapted, stable and finished to a high quality. Failure to have any piece of apparatus fit the cast is the fault of the technician; the converse is also true, namely that if the base fits the cast, but not the relevant arch, the fault often lies with the clinician.

Third clinical visit

The aims of this visit are threefold:

- To determine the form of the upper denture and to provide clear guidelines for the placement of the teeth. This may or may not involve a facebow transfer, depending on the preference of the clinician.
- To relate the mandibular arch to the maxillary arch in a reproducible three-dimensional prescription.
- To select teeth of appropriate mould and shade.

Technician's objectives

On receipt of the completed prescription from the clinician, the technician has to relate the upper cast to the articulator, the nature of which should ideally be selected by the clinician. For simplicity, a Denar™ facebow has been used throughout this section. The technician transfers the upper rim/ACB to the articulator via a transfer jig (Fig. 3). In this way, the relationship of the maxillary plane to the patient's condylar axis is transferred to the articulator, forming an equivalent relationship to the articulator's condylar axis. Prior to mounting the upper cast onto the articulator, the technician should ensure that index grooves are placed on the base of the cast (Fig. 4). This facilitates the process termed split-casting which enables casts to be remounted accurately onto the articulator post-processing. In this way, any processing-induced occlusal errors may be eliminated. To eliminate errors, the gypsum product should be mixed with water containing a food colouring and an anti-expansion agent. The former enables good colour contrast between the master cast and the mounting medium while the latter substantially reduces any small, potential errors which might arise in the mounting of casts.

An alternative option to the use of indexing grooves is the use of magnets to locate the casts to the articulator.

The second task for the technician is to mount the lower cast on the articulator in the reference established by the clinician. Again for reasons of established technological procedure, the lower base should have index grooving placed.

When the upper and lower casts are articulated, the technician uses the teeth of selected shade and mould and arranges the upper teeth as follows.

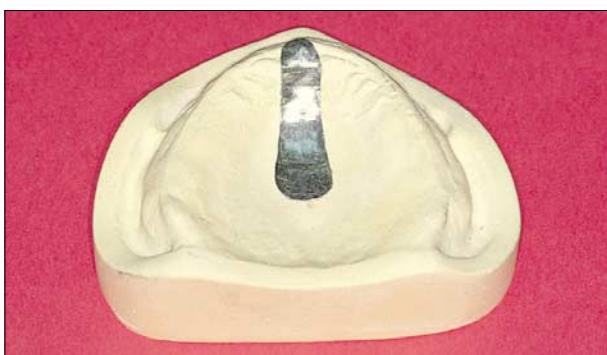


Fig. 2 1mm tin foil relief has been placed over a torus palatinus and the incisive papilla to reduce problems of support post-insertion

- To the form of the labial surface of the upper rim/ACB.
- The posterior teeth are positioned such that their palatal cusps overlay the lower ridge (Fig. 5).
- Antero-posterior and palato-buccal compensating curves commence at the upper first molar teeth.

Lower teeth are set up with the necks of the anterior teeth over the lower ridge and the central fossae of the posterior teeth overlying the lower ridge. Particulars of tooth positioning and setting up may be found in standard textbooks of dental technology or of prosthodontics.

In addition to skilled placement of the denture teeth in wax, the technician has the responsibility of combining form and function, ensuring that balanced occlusion exists in retruded contact position (RCP) in every case, and balanced articulation when so requested by the clinician.

In addition to embedding teeth in wax to restore dental appearance and function, the technician should then mould the wax representing the gingival architecture appropriately. Clearly if the clinician gives no information to the technician, then the technician can only guess the desired characterisation of the gingivae — photographs are exceedingly useful.

As was mentioned in Part 8, we recommend that two trial visits are organised. The first visit, with the six upper and six lower anterior teeth set-up enables verification of occlusal vertical dimension (OVD), RCP and the acceptability of both bases from those aspects relating to comfort, stability and the appearance of the anterior teeth. With these important aspects established, we would argue that it is easier, for both clinician and technician, to concentrate on details relating to the form of the teeth and also the gingivae. In essence, the technician should ensure that the gingival architecture satisfies four criteria.

1. It should be convex antero-posteriorly and supero-inferiorly, to indicate a healthy appearance, at the same time ensuring a hygienic, self-cleaning form.
2. It should have an harmonious arrangement of heights of the gingivae; ideally the crescent of the gingivae is highest in the middle of the upper central incisors, drops for the lateral incisors and rises again for the upper canines. The height of the gingival crescents for the upper first premolar teeth should be approximately identical to those of the upper canines.
3. The interdental papillae should demonstrate a natural pattern, ideally being longest between the upper central incisor teeth. The above three aspects are shown clearly in Figure 6.



Fig. 3 Denar™ transfer jig relates the bite-fork assembly to the articulator

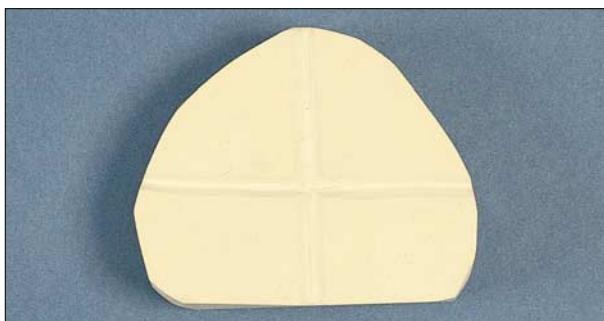


Fig. 4 Grooves on the cast facilitate removal and remount via the split-cast system. A similar mechanism is achieved via the use of magnets to retain and locate casts

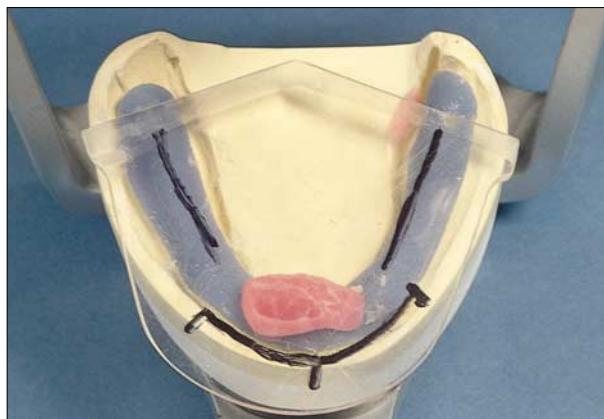


Fig. 5 The use of a translucent mounting table enables the technician to assess the relationship of the maxillary palatal cusps to the mandibular residual ridge. The anterior dark line corresponds to the outline of the upper rim. The areas corresponding to the mid-incisal point and the canine points have been marked

4. The technician should use dental floss to remove excess wax interdentally. At the trial denture stage, this merely reflects on lack of attention to detail by the technician; if unnoticed, it can result in dentures with poor aesthetic quality (Fig. 7).

Trial denture visits

There are four main aims of this visit:

- To verify that the appearance of the dentures is satisfactory.
- To verify that the occlusal requirements have been achieved.
- To confirm that speech has not been adversely affected by the form of the replacement dentures.
- To decide on any requirements for the denture base eg veined acrylic, translucent acrylic on the palate, staining, placement of restorations, etc.

When these checks have been performed, and clinician and patient are satisfied with the form and function of the trial dentures, the technician may proceed to process the dentures.

1 Guides to Standards in Prosthetic Dentistry. In A Ogden ed *Guidelines in Prosthetic and Implant Dentistry*. London: Quintessence Publishing Co Ltd, pp5-16.

Technician's objectives

Prior to preparation for processing, the tooth arrangement is rechecked to ensure no damage occurred in transit from the clinician, and that no tooth is loose. Similarly, the waxwork in relation to the teeth is checked to ensure that each tooth is securely sealed in place (this is another benefit of the use of convex interdental papillae).

The waxwork relating to the polished surfaces is also checked to ensure it is well adapted to maintain the peripheral roll.

The occlusion and teeth are double checked to ensure no alteration has occurred to the occlusion — this should be done immediately before investing as small changes might occur if sizeable alterations were made to the waxwork.



Fig. 6 Good gingival form has been created here

On the assumption that the denture base is polymethylmethacrylate (PMMA) and that the clinician has instructed the technician on the specifics of the polymer, the technician will invest the (dis-articulated) casts in the lower halves of dental flasks.

The other halves of the flasks are then used to 'hood' the teeth to be used in the denture, and

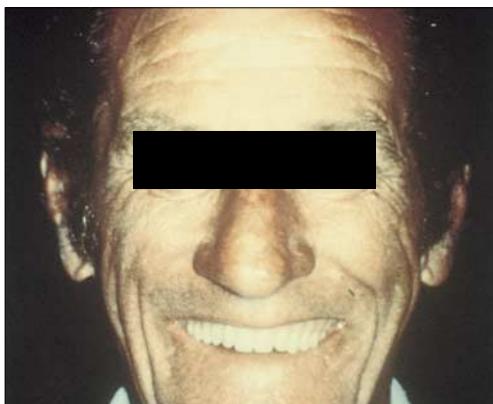


Fig. 7 Poor gingival form and careless wax control has resulted in a less than aesthetic result



Fig. 8 Well processed and polished complete dentures

the bulk of stone investing these teeth is intended to minimise tooth movement during packing and processing of the dentures.

In essence, the process of converting wax trial dentures into completed dentures comprises two stages and these involve removal of wax and replacing the wax with polymer dough/putty which is processed under pressure. The wax elimination procedure uses hot water to soften and remove the wax. Thereafter the technician has the option of using one of two techniques to process the PMMA.

The first process involves placement of the PMMA dough manually into the flasks, effecting a trial closure and then clamping the flasks under pressure and controlled temperature water bath for the appropriate curing cycle.

The second procedure involves injection moulding of pre-packaged dough/putty, under pressure into the flasks and the dentures are then processed conventionally. The pre-packaged dough has the advantage that the technician need not handle the unprocessed monomer, a factor with health and safety implications. The injecting equipment is quite expensive, but there are claims (as yet unsubstantiated) that the level of residual monomer in the processed dentures is less than with conventional methods of processing.

Following deflasking, and preliminary refinement of any flashes on the dentures, the dentures and their bases are re-articulated and the occlusion scrutinised to see that:

- The incisal pin is still on the table;
- Balanced occlusion is still present in RCP;
- Balanced articulation, if requested is still present on the articulator.

The dentures are then removed from the casts and the dentures trimmed, pumiced and polished to a high standard (Fig. 8).

Note: The high polish should not be applied to the denture teeth as this will create an unnatural appearance.

At this stage, the technician should have completed his involvement in the treatment contract — unless problems dictate otherwise. These problems will be discussed in Part 10.

Helpful Hints

1. Establish a good working relationship with your technician.
2. Clarify your design philosophies of casts, special trays, etc.
3. Take time to detail the prescription for each denture — it ensures that the detail required may be confirmed.
4. Encourage the delivery of trial dentures on articulators — this encourages attention to detail for aesthetic and functional aspects.

10

Identification of complete denture problems: a summary

J. F. McCord,¹ and A. A. Grant,²

In this section, guidelines to the diagnosis of complete denture problems are presented in tabular form. Suggestions to the management of these problems are listed.

In this part, we will discuss:

- Factors resulting in discomfort associated with dentures
- Factors resulting in looseness of the dentures
- Factors associated with problems of adaptation

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There is, inevitably, the potential for problems to arise subsequent to the insertion of complete dentures. These problems may be transient and may be essentially disregarded by the patient or they may be serious enough to result in the patient being unable to tolerate the dentures.

Factors causing problems may be grouped, essentially into four causes.

- Adverse intra-oral anatomical factors eg atrophic mucosa.
- Clinical factors eg poor denture stability.
- Technical factors eg failure to preserve the

Table I	List of factors resulting in discomfort related to the impression surface of dentures	
Symptoms/clinical findings	Cause	Treatment
Related to impression surface Discrete painful areas	Pearls or sharp ridges of acrylic on the fitting surface arising from deficiency in laboratory finishing	Locate with finger, or snagging dry cotton wool fibres. Use disclosing material to assist locality to ease denture
Pain on insertion and removal, possibly inflamed mucosa on side(s) of ridges	Denture not relieved in region of undercuts	Use disclosing material to adjust in region of 'wipe off'. Exercise care as excessive removal may reduce retention. Also clinician should only insert denture and then remove it - the patient should not occlude as this may confuse an occlusal fault with support problems
Areas painful to pressure	Pressure areas resulting eg from faulty impressions, damage to working cast, warpage of denture base. Consider also residual pathology (eg retained root), lack of relief for active frena, non-displaceable mucosa over bony prominence (eg torus)	Use disclosing material to accurately locate area to be relieved. If severe, remake may be required. Consider removal of root
Over-extension of lingual flange. Painful mylohyoid ridge; denture lifts on tongue protrusion; painful to swallow	Over-extended lower impression: instructions to laboratory not clear or non-existent	Determine position and extent of over-extension using disclosing material and relieve accordingly
Generalised pain over denture-supporting area	Under-extended denture base - may be the result of over-adjustment to the periphery, or impression surface. Check for adequacy of FWS	Extend denture to optimal available denture support area. If insufficient FWS, remake may be required
Lack of relief for frena or muscle attachments; pinching of tissue between denture base and retromolar pad or tuberosity. Sore throat, difficulty in swallowing	Peripheral over-extension resulting from impression stage and/or design error. Palatal soreness as post dam too deep	Relieve with aid of disclosing material. Care with adjustment of post dam - removal of existing seal and its replacement in greenstick prior to permanent addition may be required

Table 2	List of factors resulting in discomfort - relating to occlusal and polished surfaces of dentures	
Symptoms/clinical findings	Cause	Treatment
<i>Related to occlusal surfaces</i> Pain on eating in presence of occlusal imbalance (no support problems)	Anterior prematurity or posterior prematurity, incisal locking, lack of balanced articulation	Determine where occlusal prematurities exist. Adjust occlusion by selective grinding. If severe error remount using facebow and new interocclusal records
Pain lingual to lower anterior ridge	If no over-extension present, look for protrusive slide from RCP to ICP	Mark deflecting inclines of posterior teeth with thin articulating paper. If slide exceeds half a cusp width, re-register and reset
Pain and/or inflammation on labial aspect of lower ridge	If no impression surface defect, may be lack of incisal overjet causing incisal locking	Reduce incisal vertical overlap. If appearance compromised, resetting the incisors may be required
Pain about periphery of dentures possibly accompanied by pain in masseter and posterior temporalis muscles (classically pain increases as the day progresses)	Vertical dimension of occlusion more than patient can tolerate	If excess less than 1.5 mm, grind to provide FWS. If greater than 1.5 mm, re-register to reset dentures at new OVD
Cheek and or lip biting	For cheeks - likely that functional width of sulcus was not restored. For lips - poor lip support/inadequate anterior horizontal overlap	For cheek biting, restore functional width of sulcus and/or reset. For lips, grind lower incisors to provide a more appropriate incisal guidance angle
Tongue biting	Lack of lingual overjet - teeth generally placed lingual to lower ridge	Remove lower lingual cusps, or reset teeth
<i>Related to polished surfaces</i> Pain at posterior aspect of upper denture on opening	Flange on buccal aspect of tuberosity too thick and constraining coronoid process	Use disclosing material to accurately define area involved, relieve and repolish

peripheral roll on a master cast.

- Patient adaptational factors.

By far the most critical factors are the patient adaptational factors. Many patients with positive stereotypes may overcome errors of prescription. Some patients, however, are unable to adapt physically and/or psychologically to dentures that satisfy clinical and technical prosthetic norms. Clearly it would be in the best interests of the clinician and the patient to determine this at the assessment stage, and was referred to in Part 2.

The prescribing clinician is responsible for planning complete dentures after diagnosing potential problems; be they anatomical, physiological, pathological or emotional.

Once a denture-wearing problem becomes apparent, it is important that it is addressed in

a logical and systematic way. That is to say, an adequate history of the problem must be obtained and a careful examination of the mouth carried out so that an accurate diagnosis can be made, and an appropriate treatment plan devised.

Without doubt listening to the patient (as their difficulties are described) is the most important first step in the process, and its importance cannot be overemphasised.

Because of the plethora of potential complete denture problems, this section is largely confined to those that are most commonly encountered at the time of insertion of replacement dentures or during review appointments in the days and weeks after insertion. For a comprehensive overview of the diagnosis and management of complete denture problems, readers are referred to

Table 3

List of factors resulting in discomfort - factors with possible systemic associations. Some of these conditions may occur several months post insertion

Symptoms/clinical findings	Cause	Treatment
Burning sensation over upper denture supporting tissues, but may involve other intra-oral tissues, eg tongue.	Burning mouth syndrome often seen in middle-aged or elderly females. Denture faults must be excluded, also general organic and psychogenic factors	Correction of any denture faults, may require multivitamin/nutrition advice and treatment. Possibly antidepressant therapy. Refer to Consultant in Oral Medicine
Beefy red tongue, possibly glossdynia	Vitamin B12/folate deficiency	Refer for medical treatment
Frictional lesions related to dentures, mucosa may adhere to probing finger, may be complaint of dry mouth	Xerostomia, commonly side effect of prescribed drugs	Where some saliva flow is present, sugar-free citrus lozenges may help. Where there is an obvious paucity of saliva, artificial saliva may be considered
Tongue thrusting. Empty mouth 'chewing'. Often seen in elderly patients	May have neurological or psychological aspects. Possibly drug related	Difficult to manage. Treatment may be required to include occlusal adjustment and/or occlusal pivots
Presence of herpetiform ulcers in mouth	Herpes simplex or Herpes zoster virus. History and distribution of lesions to confirm	Dentures merely coincidental to the condition. May be useful to suggest preventive remedy (eg acyclovir) for some sufferers
Painful 'click' related to TMJ on opening and/or closing mouth and/or tenderness of muscles of mastication	TMJ pain dysfunction syndrome may be related to rapid change on OVD (either gross increase or decrease) on production of new denture. May have psychological aspects, occasionally part of general joint disease	If denture faults present, careful correction required with special care to registration and vertical dimension
Patient complains of allergy to denture material	Rare symptoms may relate to higher residual monomer content of acrylic	If excess residual monomer detected, rebase denture using controlled heat cure cycle. May need to consider remaking denture using polycarbonate resin
Painless erythema of mucosa related to support of (usually) upper denture, may be accompanied by angular cheilitis	Denture-related stomatitis. Often has a frictional element due to ill-fitting denture plus opportunistic candidal infection. Occasionally related to iron or folate deficiency	Best to leave denture out until condition clears, then remake. If not possible, correct denture faults, eg using occlusal pivots, regularly supervised and replaced tissue conditioners prior to remake. If angular cheilitis present, combinations of antifungal and antibacterial agents (eg miconazole) useful

standard prosthodontic texts.

Problems reported by patients shortly after provision of replacement dentures include discomfort, looseness or general problems in relation to adaptation. Some of these problems/difficulties may have a very large number of possible causes, and, indeed, can be multifactorial in origin. For simplicity the problems will be discussed in the order they tend to occur most frequently.

In the following tables, a list of causes and suitable forms of treatment to address the problems are summarised.

Discomfort associated with dentures

Many patients experience some discomfort for a period of up to a few days following receipt of new or replacement dentures. The great majority of patients achieve comfortable co-existence with their appliances following a short period of adjustment to the new conditions. This can be greatly assisted by a careful, detailed explanation of any difficulties that the operator might anticipate.

For some, however, especially where potential problems were not identified at examination or at the time of insertion, the consequent

Table 4	List of factors resulting in looseness of dentures - arising from decreased retention forces	
Symptoms/clinical findings	Cause	Treatment
Lack of peripheral seal	Border under-extension in depth	
	Border under-extension in width. Often a particular problem in disto-buccal aspects of upper periphery which may be displaced by buccinator on mouth opening. Posterior border of upper denture	Add softened tracing compound to relevant border, mould digitally and by functional movements by patient. Replace compound with acrylic resin. As a temporary measure a chairside reline material may be used as described above Check border is correctly sited on fixed tissue at junction with mobile tissue of soft palate. Trace thin string of softened tracing compound along impression surface of posterior border and seat denture firmly in mouth. Replace compound with acrylic resin. For temporary solution, use butylmethacrylate resin as above
Inelasticity of cheek tissues	Consequence of ageing process; scleroderma, submucous fibrosis	Mould denture borders incrementally using softened tracing-compound as functional movements are performed - aim to slightly under-extend depth and width of denture periphery. Repeated treatment may be required as inelasticity progresses
Air beneath impression surface. Denture may rock under finger pressure. May see gap between periphery of flange and ridge. Occlusal error subsequent to warpage	Deficient impression. Damaged cast. Warped denture. Over-adjustment of impression surface. Residual ridge resorption. Undercut ridge. Excessive relief chamber. Change in fluid content of supporting tissues	Reline if design parameters of denture satisfactory, otherwise remake as required. Ensure that areas of heavy contact between denture and tissues are relieved prior to impression making. Where change in tissue fluid distribution is suspected check medication (eg diuretics) posture (eg heart failure) lack of recovery of tissues from effects of old denture prior to working impressions being obtained. Stabilise fluid content of tissues and use minimal pressure impression method
Xerostomia Reduces ability to form a suitable seal	Medication by many commonly prescribed drugs, irritation of head and neck region, salivary gland disease	Design dentures to maximise retention and minimise displacing forces. Prescribe artificial saliva where appropriate
Neuromuscular control Essential for successful denture wearing: speech and eating difficulties occur	Basic shape of denture incorrect, lower molars too lingual; occlusal plane too high: upper molars buccal to ridge and buccal flange not wide enough to accommodate this; lingual flange of lower convex. Patient of advanced biological age, infirm	Correct design faults by, eg removal of lingual cusps of posterior teeth. Flatten polished lingual surface of lower from occlusal surface to periphery, fill sulci to optimal width. May require remake to optimal design. Use information from successful previous denture if available. Denture adhesives may be deemed to be necessary

discomfort can be prolonged.

In addition, discomfort may arise some time after apparently successful prosthodontic provision as a result of intra-oral or systemic changes or of denture wear or damage. Discomfort is most frequently—but not exclusively—associated with the lower denture supporting area.

The Tables (Tables 1, 2 and 3) summarise commonly experienced sources of discomfort, and means of addressing the causative factors.

Looseness of dentures

Looseness of dentures (Tables 4, 5 and 6) is more commonly associated with the lower denture, and may be referred to by patients as their denture ‘rocking’, ‘falling’ (complete upper) or ‘rising’ (complete lower), ‘shifting’ or sometimes that they ‘feel too big’.

In simple terms, retention and stability of complete dentures may be likened to a simple balance ie on one side retaining forces and on the other displacing forces. If the latter exceed the former, instability/looseness will arise. It

Table 5

List of factors resulting in looseness of dentures: arising from increased displacing forces

Symptoms/clinical findings	Cause	Treatment
<i>Denture borders</i> <i>Over-extension in depth</i> Slow rise of lower denture when mouth half open, line of inflammation at reflection of sulcal tissues; ulceration in sulcal region. Deep post dam on upper base may cause pain, ulceration	If buccal to tuberosities, denture displaces on mouth opening, or cheek soreness occurs. Thickened lingual flange enables tongue to lift denture; thick upper and lower labial flanges may produce displacement during muscle activity	Slightly under-extend denture flange and accurately mould softened tracing compound. Check borders of record rims and trial dentures at the appropriate stages. Deep post dam to be cautiously reduced and denture worn sparingly until inflammation clears
<i>Overextension in width</i> Cheeks appear plumped out. In lower, the buccal flange may be palpated lateral to external oblique ridge	Design error	Reduce over-extension. Use disclosing material to determine what is excessive
<i>Poor fit to supporting tissue</i> Recoil of displaced tissue lifts denture	Poor/inappropriate impression technique especially in posterior lingual pouch area	Reline if all other design parameters satisfactory, otherwise remake. Ensure denture is removed from mouth 90 mins prior to impression
Denture not in optimal space	Molars on lower denture lingual to ridge, optimum triangular shape of dentures absent Posterior occlusal table too broad, causing tongue trapping Thick lingual flanges encroaching on tongue space, causing lifting. Excess lip pressure to lower anterior aspect - teeth anterior to ridge, thick periphery Excess pressure from upper lip to upper denture arising from teeth too labially sited to acute naso-labial angle; or failure to adequately seat denture during relining impression procedure	Remove lingual cusps and lingual surface from relevant area, repolish. If triangular form not restored, reset teeth or remake dentures Narrow posterior teeth and/or remove most distal teeth from dentures. Reshape lingual polished surface Thin lower labial flange, ensure optimal extension to retromolar pads to resist displacement, reset anterior teeth if necessary Usually requires remaking denture

must be stressed, however, that the fulcrum is the patient, or rather the patient's ability to adapt to dentures — this is less easy to anticipate. This is illustrated in Figure 1, which is a line drawing of factors influencing complete denture stability.

Problems relating to an inability to adapt to dentures

There are a variety of symptoms which may be functionally-related (ie eating associated prob-

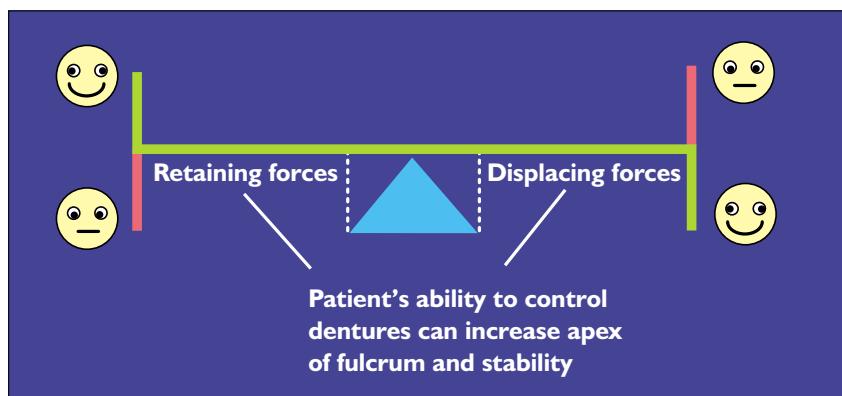


Fig. 1 Factors influencing complete denture stability

Table 6	List of factors resulting in looseness of dentures - arising from increased displacing forces - occlusal and anatomical factors	
Symptoms/ clinical findings	Cause	Treatment
Occlusal errors	<p>Uneven tooth contact causing tilting of dentures and prevents even seating of loosened appliances</p> <p>ICP and RCP not coincident - disrupts border seal and prevents accurate reseating</p> <p>Lack of freedom in ICP (occlusal-locking) dentures will shift on supporting tissues for those patients with poor control of mandibular movements</p>	<p>Adjust occlusion until even initial contact in RCP obtained. If gaps between teeth exceeds 1.5 mm reset teeth or remake dentures. For gaps less than 1.5 mm it may still be necessary, in the interest of accurate diagnosis, to remount the dentures, as a patient's mouth may be too tender to permit chairside adjustment. Adjust occlusion for coincident ICP/RCP contact. If error is greater than half width of cusp, all teeth on at least one denture need resetting.</p> <p>Remount dentures on adjustable articulator and adjust area of occlusal contact. Allow 1.5 mm of anterior movement from RCP. May use cuspless teeth where appropriate</p>
Ulceration labial to lower ridge	<p>Excessive vertical overlap of anterior teeth. Lack of balance and anterior tooth contact may cause tilting, soreness in lower ridge</p> <p>Last mandibular molars placed too far posteriorly and lie over retromolar pad or ascending part of ramus. Occlusal contact on this 'inclined plane' causes denture to slip forward</p> <p>Occlusal plane/s not orientated appropriately and masticatory forces tend to move dentures over supporting tissues</p>	<p>Reduce height of lower anteriors. Aesthetic problems may necessitate resetting of teeth</p> <p>Remove most posterior teeth from denture</p> <p>Usually requires teeth to be reset or dentures to be remade</p>
Fibrous displaceable ridge	Masticatory forces tend to cause denture to sink into and tilt towards supporting tissues	Reline after removal of acrylic from impression surface until no contact with displaceable tissue, provide many vent holes, low viscosity impression material, maximise posterior border seal
Bony prominence covered by thin mucosa (eg tori)	Denture rocks over prominence which may be covered with inflamed tissue	Remove acrylic from impression surface where disclosing material shows excessive loading of supporting tissues. Do not create excessive relief or loss of retention may result
Non-resilient soft tissue	Does not adapt to impression surface of denture reducing support and retention factors	Reline dentures to obtain optimal border extensions in depth and width, use low viscosity impression material
Pain avoidance mechanisms	Use of excessive amounts of fixative, or self-applied relining material, or even cotton wool, to attempt to relieve contact with supporting tissues	Eliminate the cause of pain

lems, speech etc), psychologically-related or may relate to patience. Clearly there is a need to diagnose the former at the planning stage of treatment and to avoid the latter by virtue of trial denture visits which focus on the functional and aesthetic components of the compete dentures.

Some of the psychologically-related problems may be recognised at an early stage but even if psychological assessments are taken, not all are infallible.

A brief list of factors affecting adaptation to dentures including their causes and modes of treatment are listed in Table 7.

Summary

This chapter has attempted to summarise in a tabular form a list of factors that are commonly found at recall visits. The tables themselves are self-explanatory and serve as a 'useful tip' list.

For more detailed lists, readers are referred to standard prosthodontic text.

PRACTICE

prosthetics

Table 7	List of denture problems associated with problems of adaptation	
Symptoms/clinical findings	Cause	Treatment
Noise on eating/speaking May be apparent on first insertion or may appear as resorption causes dentures to loosen	May be lack of skill with new dentures, excessive OVD, occlusal interference, loose dentures, or poor perception of patient to denture wearing	Where unfamiliarity present, reassurance and persistence recommended. Address specific faults or remake as required
Eating difficulties Dentures move over supporting tissues	Unstable dentures. Check that retentive forces are maximised and displacing forces minimised and all available support has been used	Construct dentures to maximise retention and minimise displacing forces
'Blunt teeth'	Broad posterior occlusal surfaces which replaced narrow teeth on previous denture. Non anatomical type teeth used where cusped teeth previously used	Where non-anatomical teeth used, careful explanation of rationale is required, may be possible to reshape teeth. Routine use of narrow tooth moulds recommended.
'Jaws close too far'	Lack of OVD, so that mandibular elevator muscles cannot work efficiently	May increase up to 1.5 mm by relining but if deficiency is greater, remake denture
'Cannot open mouth wide enough for food'. May be speech problems and facial pain especially over masseter region	Excessive OVD	Can remove up to 1.5 mm from occlusal plane by grinding, but if more is required, remake dentures
Speech problems Uncommon, but presence is of great concern to patient. May affect sibilant (eg s), bilabial (eg p,b), labiodental (eg f,v)	Cause may not be obvious. May be unfamiliarity - check that problem not present with old dentures	Check for vertical dimension accuracy, and that vertical incisor overlap not excessive. Palatal contour should not allow excessive tongue contact or air leakage - assess using disclosing paste over denture palate while sound is made. NB It is recommended that the patient's speech is assessed at trial insertion visit
Gagging May be volunteered by patient prior to treatment, or apparent at commencement of treatment or on insertion of denture	May be loose dentures, thick distal border of upper denture: lingual placement of upper posterior teeth or low occlusal plane causing contact with dorsal aspect of tongue	Construct dentures to maximise retention and minimise displacing forces. Use 'condition' appliance eg fully extended base for home use. Psychological assessment if indicated
Appearance Complaints may arise from patient or relatives. Common complaints include: shade of teeth too light or dark; mould too big/small; arrangement too even or irregular or lacking diastema	Patient failed to comment at trial stage, or has subsequently been swayed by family or friends. Perhaps the change from the old denture to the replacement denture is too sudden/severe	Accurate assessment of patient's aesthetic requirements. Ample time for patient comments at trial stage. Use any available evidence to assist - photographs, previous dentures. Consider template prosthesis
Too much visibility of teeth	Level of occlusal plane unacceptable, teeth placed on upper anterior ridge and no/poor lip support	Accurate prescription to laboratory via optimally adjusted occlusal rim
Creases at corners of mouth	Labial fullness and anterior tooth position may be inaccurate. OVD may be inadequate	Adjust tooth position as appropriate. If OVD problem, re-register jaw relations
Colour of denture base material 'unnatural'	Patient's skin colour not taken into account in determining colour of base material	Remake using suitable base material

11

Specific clinical problem areas

J. F. McCord,¹ and A. A. Grant,²

In this final article of the series, the clinical and technical aspects of a range of similar forms of immediate prosthesis are discussed. Similarly, copy denture and reline/rebase procedures are detailed.

In this part, we will discuss:

- Conventional overdentures
- Implant supported complete dentures
- Copy dentures
- Relines and rebases and construction and combination syndrome

In this section, specific clinical problem areas, which involve aspects over and above conventional complete dentures, will be discussed. The six areas to be discussed are:

- Conventional immediate complete dentures
- Copy (template) dentures
- Relines and rebases
- Overdentures (complete)
- Implant-retained/supported complete dentures
- Combination syndrome.

In addition to having to satisfy prosthodontic norms for conventional complete dentures, all six areas require distinct planning procedures, which relate to both technical and clinical procedures, yet they tend to share common problems, particularly with regards to retention and stability of complete dentures. The six categories are summarised and readers are referred to standard textbooks for more comprehensive descriptions.

Conventional immediate complete dentures

According to Nimmo and Winkler, an immediate denture may be defined as 'a complete or removable partial denture constructed for insertion immediately following the removal of natural teeth'.¹ Such dentures were once provided on a regular basis in dental practice, especially in the post World War II era. For a variety of reasons, one of which is improved dental health education, this treatment regime is now less regularly provided.

In the interests of simplicity, and to avoid repetition for the remainder of this chapter, the term immediate denture will be intended to mean an immediate complete denture.

In theory, immediate dentures may be defined as interim or conventional. In the former, an existing (partial) prosthesis is converted into a complete denture. In the latter, conventional wisdom recommends that posterior teeth distal to the first premolar teeth are extracted, the ridges allowed to heal for 2–3 months and the anterior teeth subsequently extracted and a conventional immediate denture inserted.

Table 1 lists the potential categorisation of immediate dentures and also of overdentures. There are obvious similarities between the two

from planning and technological points of view but the latter offers greater patient benefits (*vide infra*).

Transitional immediate complete dentures

In this category, a patient who is currently wearing a satisfactory removable partial denture is rendered edentulous and the teeth to be replaced are added to the denture. Additional base material, to effect maximal coverage of the denture-bearing area, is also provided. This is the philosophy behind training dentures and is the rationale behind the prescription of, eg Kennedy I type dentures in older patients for whom the prognosis of the remaining teeth is poor. After a period of time to enable, it is hoped, neuromuscular control of the training denture, an impression is taken with the training denture *in situ*. The resultant master cast is then modified by removal of the remaining teeth (see conventional immediate complete dentures) and the transitional denture processed. Figures 1–3 show the clinical stages in the transformation of the partial denture to the transitional complete immediate denture.

Conventional immediate complete dentures

Although a range of clinical scenarios are possible, the most common clinical situation, and the one to be described is where the posterior teeth have been extracted and the anterior teeth remain. There is much merit in retaining, if possible, the four first premolar teeth to provide a reasonable and unambiguous occlusal stop in retruded contact position (RCP), and this provides an acceptable assessment of occlusal vertical dimension (OVD). The technique described here may be used if the premolar teeth are present or not.

Stage 1

The teeth to be removed are assessed clinically and radiographically, and an assessment of the levels of the alveolar bone made. Primary impressions are made using, eg a combination of impression compound and irreversible hydrocolloid (Fig. 4).

NB Although trays do exist for partially-dentate patients, we recommend, nevertheless, the combination of a viscous material (for the sad-

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Table 1	Theoretical categories of immediate dentures and overdentures		
Type of denture	Transitional	Immediate	Definitive
Conventional immediate	<ul style="list-style-type: none"> • Previous partial denture used and converted to a complete denture. • After an appropriate period, a conventional replacement (definitive) denture is made. 	<ul style="list-style-type: none"> • Posterior teeth removed, and after a set time, the remaining teeth are extracted and the complete immediate denture is inserted. • After an appropriate period, a conventional replacement (definitive) denture is made. 	<ul style="list-style-type: none"> • Not an accurate description here, as, by definition, conventional immediate dentures cease to be so on insertion, owing to the nature of extractions and subsequent resorptive processes.
Overdenture	<ul style="list-style-type: none"> • Previous partial denture used and converted to a complete denture. • After an appropriate period, a definitive replacement overdenture is made. 	<ul style="list-style-type: none"> • Posterior teeth removed, and after a set time, the teeth selected as overdenture abutments are prepared to receive the overdenture and the complete immediate denture is inserted. • After an appropriate period, a definitive replacement overdenture is made 	<ul style="list-style-type: none"> • In this category, the dentures receive some or most of their support and perhaps retention and some stability via either <ol style="list-style-type: none"> i. abutment roots +/- precision attachments ii. implants + precision attachments

dle areas) and a less viscous impression material for the areas where teeth are retained, as the philosophies for primary impressions outlined in Part 4 apply here.

It is also worth mentioning here that patients ought to be informed of the fact that immediate dentures represent a useful solution to the advent of edentulousness. These dentures may require several chairside relines

during the first 3 months after insertion of the immediate denture(s) and will require to be replaced some time after that (although, some patients have coped with immediate dentures for many years). The medico-legal implications of this important piece of information should not be overlooked and Figure 5 shows a patient information leaflet regarding complete dentures.



Fig. 1 Occlusal view of remaining teeth and present lower partial denture



Fig. 2 Occlusal view of remaining teeth and edentulous saddles

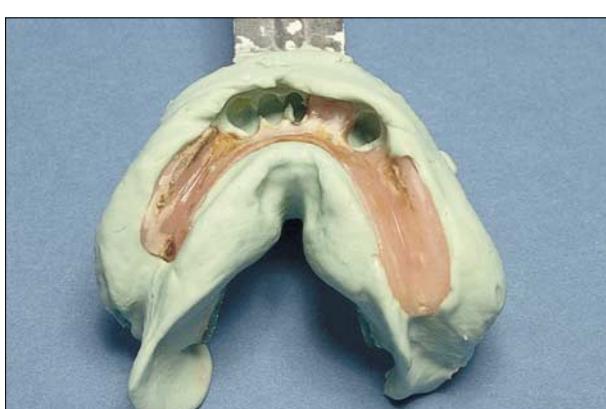


Fig. 3 Pick up impression showing current denture and remaining teeth. It is a simple matter for the technician to add the remaining teeth to the present denture



Fig. 4 Stock tray modified with impression compound in the saddle area and overall irreversible hydrocolloid impression material

Figure 5

Instructions to patients receiving immediate dentures

A great deal of care and skill has been used in the production of the denture(s) that you have received. To enable you to learn to use the denture(s) as quickly as possible and get the greatest benefit from them, you are asked to note the following advice.

1. Do not remove the dentures yourself. Your dentist will remove them at your next appointment.
2. If pain occurs relief may be obtained by taking two paracetamol tablets at not less than four-hourly intervals.
3. Eat only soft foods at this stage and rinse the mouth lightly after meals.

Next appointment

This appointment will normally be arranged about 24 hours following the extractions. Your dentures will be removed and any treatment necessary to improve your comfort will be carried out. You will be shown how to remove and replace the dentures and your next follow-up appointment will be arranged.

Home care

1. Eating may be difficult at first; cut your food into small pieces and take your time chewing. Avoid tough and sticky foods over the learning period.
2. Remove your dentures and clean them after each meal. A soft brush with soap and cold water are satisfactory for cleaning. Alternatively, a proprietary denture cleaner may be used following the manufacturers' instructions. Rinse the mouth thoroughly with warm water before replacing the dentures.
3. Wear the dentures night and day, removing them only for cleaning. (You will be advised when you can begin to leave the dentures out at night).
4. Pain and soreness sometimes occur with new dentures and adjustment may be required. Arrange an appointment to see your dentist as soon as possible. Do not attempt to adjust the dentures yourself.
5. We are obliged to inform you that, following tooth extraction, the bone of the jaws surrounding these teeth is resorbed (shrinks). In consequence, your dentures will become progressively looser. As a result your dentures will need to be relined and, usually after 6 months replaced by new dentures.

Fig. 5 Patient information leaflet on immediate dentures

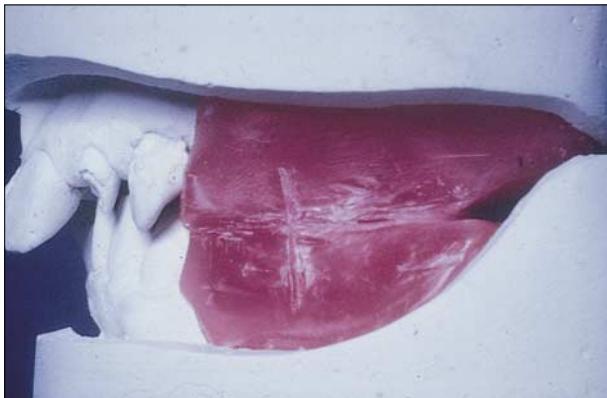
Stage 2

A definitive impression is made. It should be emphasised that time should be taken to ensure that the peripheries are appropriately extended. Patients who have never worn complete dentures previously will have to endure enough adaptational problems without having to cope with instability as a consequence of over-extension. Again, the clinician should specify to the technician the amount of spacing required, according to the type of impression material to be used.

Stage 3

Registration of intermaxillary relations. As with conventional complete dentures, vertical, antero-posterior and coronal relations need to be recorded and record rims (Fig. 6) will help

Fig. 6 Record rims on master casts to record inter-maxillary relations



the clinician to record these relations. It may be possible to use the remaining anterior teeth as a means of selecting the mould and shade of the teeth for the immediate denture; in some cases, the remaining teeth may not lend themselves to copying and a conventional method may be used to assess tooth selection (*vide supra*).

Stage 4

The three-dimensional inter-maxillary relations are confirmed at the trial denture stage as is the shade and form of the teeth. The information above, plus details of pocket depth enable the technician to determine where to position the necks of the replacement teeth. Equally, the clinician should decide whether the immediate denture has no flange (open-faced) a short flange (ridge-lapped) or whether a full flange can be accommodated. The presence of large undercuts may rule out the latter (Figs 7 and 8). In such cases, and where there is a need to attempt to restore a semblance of the interdental papillae, the flange may be taken to the bulkiness of the alveolar undercut using a short flange. Readers are referred to textbooks of prosthodontics for details of the technical procedures.

The dentures are then completed ready for insertion following an effective cross-infection regime prior to the required clinical procedures.

After the insertion of the immediate dentures, the patient is given instructions on the care of their dentures (see Fig. 5) and reviewed after 24 hours and then weekly, according to patient need until the clinician prescribes a reline. This may be a conventional type of reline or a 'chairside' reline using an auto-curing material.

Copy (template) dentures

Although impression techniques relating to this form of treatment were outlined in Part 4, we feel that it is appropriate to elaborate on the philosophy of template dentures. Over 30 years ago, Brill recognised that some patients, particularly elderly patients, had problems adapting to the (new/altered) form of replacement dentures.³ He argued that retention of the form of the polished surfaces of the dentures and relining/rebased of the impression surfaces (denture bases) would enable the dentist to provide replacement dentures to which (older) patients might adapt more easily. This philosophy led to the birth of the 'copy' denture technique. If all surfaces of the complete denture were being replicated, this would indeed be a 'copy' denture. If only the polished surface is being replicated, however, then we would argue that the technique should be considered a template technique, as the denture bases and the occlusal surfaces are altered, only the polished surface is 'copied'. A variety of techniques was referred to

in Part 4, and practitioners should use the one that works best for them.

There is no doubt that the template technique is a sensible and effective treatment strategy for older patients, or those patients who because of neurological impairment are unlikely to develop good muscular adaptation to conventional complete dentures.

The clinical stages for template dentures are:

- At the first visit, after appropriate history recording and diagnosis, prior to templating, primary impressions may be made. As was described in Part 4, the existing dentures are replicated. Given the stability of polyvinylsiloxane putty systems, we would recommend the techniques whereby this is used, especially for practitioners who do not have casting services on the premises.
- At a second clinical visit, impressions are made within the replicated dentures; this serves effectively as a relining/rebasing to improve the fit of the denture base to the denture-bearing tissues. The occlusal surfaces are then modified to a new OVD and RCP if desired.
- At the third visit, the wax trial denture is assessed and if the dentures are perceived to be satisfactory by both the clinician and the patient, the dentures are sent to the laboratory to be processed conventionally.

This technique has been shown to result in successful resolution for those clinical cases (*vide supra*) in which conventional prosthodontics might not have worked. Although the concept of template dentures is philosophically simple, it nevertheless requires that the clinician exercises appropriate clinical skill and judgement.

Three areas of caution, in particular are worthy of consideration.

- Ensure, in the older patient especially, that the OVD is carefully selected. This problem has already been referred to in Part 6.
- None of the currently described techniques adequately caters for problems of support (eg displaceable upper ridge) and modifications of impression techniques may be necessary to overcome these problems.
- This technique requires that the technical support is proficient. If the replication of the denture form is not thorough, the outcome of the treatment may be jeopardised.

Relines and rebases

Although one technique for a 'reline' impression was described in Part 4, this merely describes how to do it. We feel that this approach, while appropriate to a chapter describing impression techniques, requires elaboration, hence we have included some comments here on the basic principles of

relining/rebasing, as we feel that this procedure is often mistakenly assumed to be a 'simple' procedure that tends to be performed poorly.

Residual ridge resorption under denture bases is an inevitable occurrence and all patients ought to be informed of this. As was described earlier, this resorption may be pre-



Fig. 7 This immediate denture has been designed with a full labial flange

dicted to occur rapidly over the first 3 months post-extraction then slow down, although there will inevitably be great variation among patients. Dentists, we feel, should be mindful of the need to maintain the adaptation of the denture bases to the selected areas of the denture-bearing area.

In order to compensate for residual ridge resorption, the impression surfaces of the dentures may on occasion be modified; the two processes whereby this may be carried out are termed relining and rebasing.

According to the *Glossary of Prosthodontic Terms*, relining describes the procedures used to resurface the tissue (impression) surface of the denture with new base material,² thus producing an accurate adaptation to the denture foundation area.

In the same document, a rebase is described as the laboratory process of replacing the entire denture base of an existing prosthesis.

In essence, the process of relining is carried out on mandibular complete dentures and the process of rebasing is carried out on maxillary complete dentures, although many practitioners use the term reline to mean both.

The indications and contra-indications for relining/rebasing are listed in Table 2.

Further factors to be taken into considerations for relining and rebasing are:

- The OVD should be acceptable (where minimal freeway space (FWS) is present, this could induce further denture-wearing problems).
- There should be occlusal balance in RCP, or should be easily achievable if not present.
- The dentures are adequately extended, or may be easily rendered so via a chairside reline material or tracing compound, prior

to the recording of the impression — there is little point in relining a denture that does not satisfy prosthodontic norms.

The clinical and technical procedures for replacement of the denture base of complete dentures are relatively complicated and require clinical competence — if denture bases are severely under-extended, unattainable balanced occlusion exists in RCP and a gross loss in OVD has occurred, practitioners are advised to prescribe replacement dentures.

Overdentures

According to Basker *et al.*, overdentures are prostheses constructed to gain support and retention from retained roots (or dental implants).⁴ In this section, the term overdentures is intended to mean complete denture overdentures.



Fig. 8 Owing to an obvious labial undercut, there has been no attempt to place a full flange and an open appearance has been created.
NB Socketing is not recommended as it encourages an inappropriate appearance post-healing

In essence, the retention of roots to support/retain an overdenture has been shown to reduce residual ridge resorption, improve stability and to retain proprioception.³ For a more detailed description of overdentures, readers are recommended to standard textbooks on the subject.^{4,5}

As is described in Table 1, overdentures may be classified as being one of three classes, transitional, immediate and definitive.

Transitional overdentures

As with the immediate denture category, a partial denture worn by the patient is modified by addition of teeth; the planned retention of two or more roots facilitates adaptation to complete dentures, in addition to reducing ridge resorption. In all other respects, the clinical and laboratory stages are similar to those of transitional immediate dentures. In this technique, the teeth are reduced in height (to the level of the gingival margins) at the time of the insertion of the denture. To guard against rocking of the denture on insertion, the clinician is advised to reduce the teeth on the master cast above the gingival margins. This will ensure that there will be a small space between the overdenture abutment teeth and the denture; this space may be filled in by a chairside reline material to ensure stability of the transitional immediate denture.

Immediate overdentures

The clinical and technical stages of this type of overdenture are essentially similar to that of immediate overdentures. The clinical differences are clearly that a planned number of roots are retained and, post-decoration, the clinician has to decide how best to seal-off endodontic access cavities (if endodontic procedures have been carried out) or of dentinal tubules if elective endodontics has not been performed.

It is not established practice to place precision attachments in immediate overdentures.

A second point is that, in these situations, hard tissue undercuts tend to contra-indicate full labial flanges and most immediate overdentures tend to have a ridge-lapped appearance (Fig. 8). In these cases, there is no real flange but the acrylic of the denture base is extended up to the ridge undercut. In addition to improving the appearance of the denture by incorporating interdental papillae, this technique helps mask some resultant ridge resorption.

Table 2

List of indications and contraindications for relining and rebasing

Indications	Contra-indications
<ul style="list-style-type: none"> • 3–6 months post insertion of immediate complete dentures. • When adaptation of denture bases to the tissues of the denture-bearing areas is poor. • When, for medical or social reasons the patient is unable to attend the required number of visits for replacement dentures and no contra-indications apply. • When the patient is unable to afford replacement complete dentures and no contra-indications apply. 	<ul style="list-style-type: none"> • When an excessive amount of resorption has occurred. • When the underlying tissue is inflamed and/or hypertrophic or hyperplastic. • When the patient exhibits symptoms suggestive of TMJ problems. Accurate diagnosis and resolution of the problem are indicated first of all. • When the dentures have induced a speech problem. • When the appearance of the dentures is unsatisfactory to the patient. • When the intermaxillary relationships are unsatisfactory.

To avoid embarrassment of a social nature to the patients (and of a professional nature to clinicians) it can be reasonable practice to use denture fixative at the time of insertion of this overdenture type. This is especially valid if the patient has never worn a denture previously, as the (soft) tissues of the denture-bearing area may take some time to be displaced.

Definitive overdentures

At a selected period post-extraction and de-coronation and insertion of either a transitional overdenture or an immediate overdenture, a replacement overdenture may be planned. This replacement denture may be a straight-forward replacement complete denture which happens to be an overdenture; in this case, conventional techniques would suffice.

If, however, there is a need to improve retention, the clinician may decide to use precision attachments. The two most common precision attachments used for overdentures are studs (Fig. 9) and bar assemblies (Fig. 10). The reader is referred to a textbook on overdentures on indications and contra-indications here, eg if a bar is selected, then it tends to assume that the roots are approximately parallel.

When the clinician has determined which type of precision attachment is appropriate for the patient, the treatment sequence followed is as follows:

- *Stage 1.* Primary impressions recorded as for the conventional denture technique. The technician should be informed of the decision to prescribe precision attachments and the case planned with the laboratory before proceeding further.
- *Stage 2.* If the abutment teeth have been endodontically-treated, then the root canals of selected teeth (usually canine teeth) are prepared with reamers matched to impression posts to give parallel-sided threaded posts. One such system is illustrated in Figure 11. Definitive impressions are recorded, again with the same attention to detail for peripheral seal as per conventional dentures.
- *Stage 3.* The appearance of the upper denture, intermaxillary relations and selection of tooth moulds and shades are carried out as for conventional dentures.
- *Stage 4.* In addition to the trial insertion(s) for the denture(s), the clinician should verify the accuracy of fit of the precision attachments. When precision attachments and trial denture are deemed to be satisfactory, the overdentures may be processed.
- *Stage 5.* As the retention of teeth does significantly enhance function and retention of lower dentures particularly, extreme caution is advised to ensure that the occlusal schemes of the dentures are in harmony with



Fig. 9 Studs used to retain lower complete overdenture



Fig. 10 A bar assembly used to retain a complete lower overdenture

mandibular movements, or (upper) denture instability may well result.

- *Stage 6.* As with all other denture types, review visits and recall visits are necessary.

Patients should be made aware of the need to maintain good oral hygiene around abutments. They should also be informed that maintenance is required for the precision attachments; the effects of wear and tear on the precision attachments means that tightening and/or replacement will be inevitable at some time.

Implant-retained complete dentures

An implant is a device or substance that is placed or implanted in the body for the purpose of restoring lost or deficient function and/or the replacement of deficient tissue. A dental implant is implanted into or onto the tissues of



Fig. 11 Para-post system which has reamers, which match impression posts



Fig. 12 Impression posts for a lower, implant-retained complete denture using the IMZ (Friatec™) system



Fig. 13 Impression posts for a lower, implant-retained complete denture using the Nobel-Biocare™ system

the jaws with the object of providing anchorage for a fixed or removable prosthesis, or for the augmentation or regeneration of deficient tissues. Clearly with such a general definition, a range of implant materials and implant types may be used. For the interests of this chapter, the implant material discussed is titanium (or alloys of titanium) and the type of implant referred to is the endosseous implant. Examples shown demonstrate two types (Nobel-Biocare™ and Friatec™) and these reflect the clinical experience and preference of the authors.

Substantial data are available to indicate the very real functional and psychological advantages of restoring edentulous jaws with dental implants,^{6,7} and there is no doubt that this treatment modality is practised universally by specialist prosthodontists and general dental practitioners. We would recommend that clin-

cians undertaking such treatments undergo sufficient clinical training to comprehend the surgical and prosthodontic philosophies inherent in well-established and creditable implant systems.

We would further contend that the restorative clinician is the orchestral leader of implant therapy as they should be involved with treatment planning at the onset of treatment, establishing the form of the surgical template, prescribing the intermediate and definitive prostheses and overseeing the maintenance of the prosthesis/es.

The prosthodontic stages inherent in implant-retained (complete) denture therapy, in addition to treatment planning stages are as follows:

- *Stage 1.* The clinician proceeds with the case as for a conventional denture and, at the trial denture stage, when satisfied with the form and function of the trial dentures, arranges the surgical stent(s) required. One such stent is illustrated in Fig. 3 of Part 8. The surgeon uses this stent to help position the implants.
- *Stage 2.* Post-insertion of the implants, the patient is advised to refrain from wearing their denture for 1 week. Thereafter, successive resilient linings will be required to reduce trauma to the tissues overlying the implants. Relief will also be required over the site of the implants to reduce the potential for loading of the implants during this period when, it is hoped, osseo-integration is occurring.
- *Stage 3.* After the implants have been uncovered and healing caps placed on the perimucosal abutments, impressions are taken. Figures 12 and 13 indicate two systems and their different (although fundamentally similar) impression techniques for implant-retained complete dentures. In the particular case shown in Figure 12, the central implant was not utilised and subsequently covered up to allow room for the bar assembly.

In essence, the stages following this are similar to those described above for definitive overdentures, with the exception that the abutments used are screwed in place.

Figure 14 is an intra-oral view of an implant-supported bar assembly *in situ*.

As with overdentures, the need to include maintenance visits should always be emphasised to the patient.

Combination syndrome

Reference has been made previously to the difficulties encountered by having to provide a replacement complete denture in one arch while the opposing arch contains a natural (or essentially natural) dentition; this challenging clinical combination has been termed the combination syndrome. Two types exist: edentulous maxilla



Fig. 14 Intra-oral view of implant-supported bar assembly

opposed by natural dentition and edentulous mandible opposed by natural dentition.

Edentulous maxilla opposed by a natural dentition in the mandibular arch.

In this situation, the displacing forces on the upper denture resulting from mandibular movements have to be harnessed and a variety of ways of maximising the retentive forces and reducing the displacing forces must be used.

The retaining forces are maximised by ensuring that a peripheral seal is present and this has been described in an earlier chapter.

Displacing forces are reduced by co-ordinating the maxillary teeth and maxillary plane of occlusion to mandibular movement. These are achieved via one of the following ways:

- Using a facebow to transfer the plane of the upper arch to the condylar axis.
- Using a central-bearing screw to create an arrowhead (Gothic-arch) tracing.
- Setting the articulator condylar angles to accord to the border tracings on the arrowhead tracing.
- Establish, carefully, at trial insertion, that RCP is reproducible.
- That the technician 'mills' the occlusion to suit the patient. This will inevitably be necessary, as (denture tooth) cuspal inclines will be unlikely to equal those of the patient. This should not be carried out without consideration of aesthetic and functional demands of the patient and should be carried out in advance of the recording of definitive impressions of the mandibular arc.
- On occasion, the clinician may need to use the patient to 'mill-in' the occlusion in the chair. A technique sometimes used by the authors is to make a paste of carborundum powder and toothpaste and to ask the patient to trace out the border movements with the denture *in situ* and with the teeth in occlusion.
- In our clinical experience, there has inevitably been a need to review the patient after 3 days and to refine the cuspal anatomy of the maxillary denture teeth.
- Clinicians should be aware of the need to maintain and even replace dentures in these conditions, hence patients should also be so informed at the onset of treatment.

As with most complete denture problems, patient co-operation is essential if success is to be achieved.

Edentulous mandible opposed by a natural dentition in the maxillary arch.

This clinical problem is even more difficult to treat than the former and although identical techniques are recommended in this scenario, success will be more problematic. Even with sound prosthodontic impression techniques, displacing forces will inevitably overwhelm retaining forces of the mandibular denture and only immense physiological control of the denture will create stability. In this clinical situation, implant-retained dentures are in a class of their own as a preferred treatment modality.

Although other problematic clinical situations exist, we have attempted to cover the principal situations which may be encountered in daily general dental practice and this section, in addition to Part 10 gives, it is hoped, an insight how to identify and treat common prosthodontic problems.

Helpful Hints

1. For any form of immediate denture, always inform first-time complete denture-wearers of:
 - a: the problems associated with managing complete dentures and
 - b: the inevitable residual ridge resorption and its sequelae.
2. Immediate complete immediate dentures or complete overdentures — the clinician should ensure that the essential principles of complete denture prosthodontics are adhered to.
3. Where complete upper overdentures are concerned, tissue displacement (and associated tissue fluid displacement) usually does not occur at the time of insertion of the denture and a denture adhesive may be required over the first 24–48 hours. The patient should be advised (of this possible transient retentive aid) before the insertion-visit to avoid the patient developing a negative stereotype towards the dentures and/or the clinician.
4. Where precision attachments are used for conventional overdentures or implant-retained overdentures, the clinician should remember that they occupy space and may be bulky. The clinician is also advised to consult with his/her technician, at the treatment planning stage, as to the technical feasibility of each case.

This series is available as a BDJ book — *A Clinical Guide to Complete Denture Prosthetics* by Professor J F McCord and Dr A A Grant (ISBN 0 904 588 64 5, price £29.95) This can be purchased from Macmillan Direct, Brunel Road, Hounds Mills, Basingstoke, Hants RG21 6XS Tel: 01256 302699

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